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Four-Spindle Milling Machine.

We illustrate herewith a milling machine, which, though the first one built was designed especially for printing-press work, is adapted to any work that may require to be milled on two or three of its sides. The particular pieces first designed to be done upon it required to be milled on top and on one side only, and two of them were therefore placed side by side upon the platen, one vertical and one horizontal spindle being devoted to each piece. The vertical spindles are placed 4 inches ahead of the side spindles, so that when the face mills used on top and at the sides work clear up to the corner they clear each other.

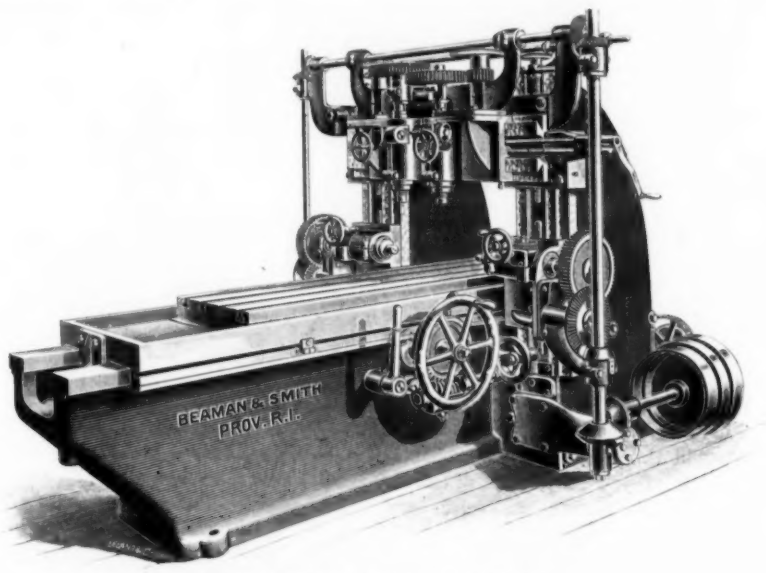
The horizontal spindles have a horizontal adjustment of 3 inches each, varying the distance between them from 19½ inches to 25½ inches, and the saddles carrying them can be adjusted vertically upon the housings from the platen to the cross rail.

The vertical spindles have 3 inches independent vertical adjustment, and the cross rail also is movable upon the housings in the usual manner, so that the spindles can be brought down to the platen, or raised 18 inches above it.

All the spindles run in quills which are adjustable by means of worm, worm wheel, rack and pinion, and can be clamped at any setting.

All the spindles are driven by positive gearing in the manner indicated, and the feed motion is taken from the back of cone shaft through change gears, giving positive feed of platen from 1 inch to 12 inches per minute, the motion being transmitted through worm gearing to a nut which revolves upon a stationary screw. Steel balls and hardened collars take the end thrust. The feed is tripped automatically.

The platen of the machine shown is 20 inches wide and 8 feet long on the work surface. The housings, and, in fact, all parts of the machine, have been made exceptionally heavy, and the platen rests upon broad flat surfaces to which it is gibbed, the idea of the design being to secure the greatest possible rigidity without sacrificing convenience of operation. The machine is made by Beaman & Smith, Providence, R. I.



FOUR-SPINDLE MILLING MACHINE.

The Differential Speed-Reducing Fallacy.

BY GEO. B. GRANT.

This thing that is so new periodically, like the idea of getting power by using the exhaust steam of an engine to raise steam from a volatile liquid, and, like that, so plausible until tried, and, like that, so prolific in producing stock companies, is the well-known differential train of gears shown by my figure 1. The pinion *A* is on a high-speed shaft, but loose on it with its center eccentric to that of the shaft, and it gears in two internal gears *B* and *C*. The gear *C* is fixed, and the gear *B* is thus driven at a very slow speed due to a difference of one or two teeth in the numbers of teeth in the two internal gears. If *B* has a hundred, and *C* has a hundred and one teeth, the speed of *B* will be about one-hundredth of that of *A*. Nothing but a worm gear could be prettier, or more compact, or better suited for mystifying the unsophisticated.

This device will reduce the speed undoubtedly, but there its virtues end. The pressure on the teeth of the gears will be that due to the slow speed of the driven gear, while the high-speed pinion is hard at work wearing the metal off the teeth. The combination of high-working speed under high-working pressure will soon wear the thing out. It has no application in practice, and is suitable only for a college-gear model which has only the pressure of the atmosphere to overcome.

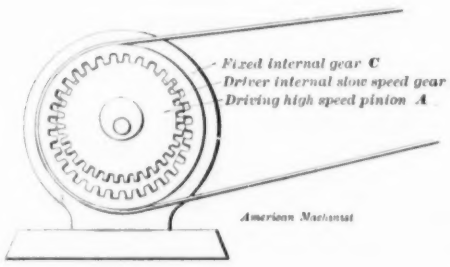


Fig. 1

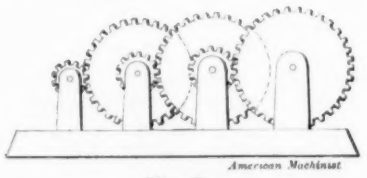


Fig. 2

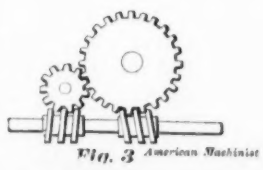


Fig. 3

SPEED-REDUCING MECHANISMS.

Every little while I am called upon to make a set of gears for a speed-reducing rinctum that no good mechanic would harbor in his head for a minute, but which is so pretty that it has to be tried by the unmechanical before its cussedness is apparent. Capitalists and statesmen may be easily humbugged with the idea, and their cash extracted by adventurers who claim to have invented it for some important purpose, such as, for example, reducing the high speed of an electric motor to the slow speed of ordinary machinery, and it is well to show up the fraud.

I was once stuck by the pretty thing myself, when I wanted to reduce the high speed of the cutter shaft of a gear-cutting machine to the slow speed of the feed shaft, for I supposed it would stand that small service. It worked well for about a month, but it will not play any more tricks on me.

Then, again, there is the worm and gear, so well known and little understood, that is often applied for bringing speed down and power up. The friction on the teeth of the gear will waste from twenty to sixty per centum of the whole power applied, and it is entirely unsuited to the purpose. The double form shown by Fig. 2 is the only practicable worm-speed reducer, and that has few virtues except compactness.

And we have all this fuss with differential gearing and worm gearing right in the teeth of the fact that we have in the ordinary train of gears, Fig. 3, which nobody can patent, a speed-reducing device that is at once cheap, compact, and remarkably efficient. The power is rapidly reduced by this homely device, and the speed comes down with it, so that we have great strain only on the parts that move at a slow speed. It can be arranged so that it is nearly as compact as either the differential or worm device, and it is superior to either from every point of view.

Lexington, Mass.

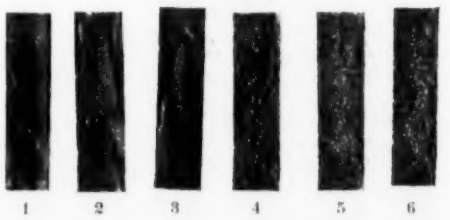
Tempering Scientifically.

BY A. A. SIMONDS.

Much has been published on the subject of hardening and tempering steel, but after the best articles have been examined one comes necessarily to the conclusion that very little is really known about the changes that take place or when they occur. Naturally enough, then, there exists a desire for more definite and more exact knowledge upon the subject. After thirty years' personal experience in the edge tool business, and my father before me with thirty-five years (he being successor to an edge tool manufacturer, who preceded him for thirty years) about the only information that has been handed down is to heat to a "cherry red" and immerse in a cold bath. "Cherry red," at best, is a vague term, meaning one thing to one workman, another to another. Long experience alone has taught the temperer to judge approximately at what heat steel containing various proportions of carbon must be hardened. Realizing the uncertainty of the present methods, I have desired for years to secure more definite results, and have often thought that the time must come when hardening and tempering would be done in a more reliable way.

After a year and a half's experimenting in tempering in a more scientific manner, aided by my thermo-electrical pyrometer, I propose to give the readers of the AMERICAN MACHINIST the result of my labor, covering hundreds of experiments. To begin with, there is an exact point at which a piece of steel should be heated to give the best results. If the temperature falls *a little* below this point, the formation of the steel appears coarser than when heated at the proper temperature; if raised slightly above, the effects of overheating show very rapidly. Most of my experiments have been made with steel 1 inch wide and ¼ inch thick; my reason for selecting this size being that steel will not harden through when much thicker. Larger pieces it is impossible to harden thoroughly all through except by overheating, which injures the cutting qualities. To illustrate, the cut, Fig. 1, shows a piece of round steel 1⅛ inches in diameter, hardened and broken in two pieces, showing clearly the internal formation. The outside circle, about $\frac{1}{10}$ of an inch thick, brings out perfectly the true formation of well-hardened steel. Inside of this circle the steel has not taken temper. My other experiments give the same result, so that I am driven to the conclusion that large pieces cannot be hardened properly more than about $\frac{1}{10}$ of an inch from the surface, except by overheating. The reason for this is apparent; in a thick piece of steel the internal heat cannot be absorbed quickly enough to produce a hardened formation.

Fig. 1.



EFFECT OF VARYING HEAT.—FIG. 2.

The question will at once be asked, "What is the proper temperature?" I see that one French writer gives the temperature at 1,292

Fahr. From my experiments I conclude that steel of different carbons hardens at different temperatures. For instance, steel containing 1¼ per cent. carbon will harden at a somewhat lower temperature than steel containing only $\frac{6}{10}$ per cent. carbon; and, therefore, the composition of the steel is a matter which must be taken into consideration; also the composition and temperature of the bath has an influence on the hardening point.

The engraving, Fig. 2, represents the fractures of six pieces of the same bar of steel, 1 inch wide and ¼ inch thick, that have been hardened at different temperatures and broken on a Riehlé testing machine, the bars resting upon supports 6 inches apart.

No. 1 shows a very fine grain, except in the center. Here it has not hardened, as it can be filed readily when the outside shell has been ground away. No. 2 is well hardened through. No. 3 is slightly overheated and the grain appears coarser. No 4 looks in the cut the coarsest of all, but in reality it is not as coarse as 5 or 6, its appearance being caused by a kind of mealy formation. No. 5 is coarser than the four preceding ones, but is not as coarse as No. 6.

The temper was not drawn in any of these pieces, but they were left as they came from the quenching bath.

No. 1 (with its soft center) stood a breaking test of 1,550 pounds.

No. 2 stood a breaking test of 1,010 pounds.

No. 3 stood a breaking test of 825 pounds.
No. 4 stood a breaking test of 665 pounds.
No. 5 stood a breaking test of 420 pounds.
No. 6 stood a breaking test of 350 pounds.

The difference in temperature between each piece (No. 1 being the lowest) was 40° Fahr. Repeated experiments have given similar results, so that I am satisfied that good hardening must be done within a very narrow range of heat.

As for the question of time, I find that the duration of heating is not as important a feature as it is generally considered. The overheating of steel is the cause of the greatest injury and not the time that it is in the fire. I do not mean to say that steel cannot be injured at a low heat when it is left in the fire a long time, but that pieces which have been in the fire thirty minutes, and two hours, respectively, show very little difference in their breaking strength. I do not, however, recommend any unnecessary time to be wasted in bringing the steel to the desired temperature.

During the last few months I have caused to be placed in the hands of fourteen different manufacturers, in different sections of the country, seventy pieces of American steel, all of the same lot, 1 per cent. carbon. These pieces were 6½ inches long, 1 inch wide, and ¼ inch thick. Five were given to each concern, with the request that they carefully harden them. I then had them returned to me and tested upon a Riehlé testing machine, with supports 6 inches apart. The following are the results, the figures indicating the breaking loads:

Lbs.	
100	
255	
555	Average, 265. Saw Manufacturer.
235	
180	
150	
325	
275	Average, 288. Agricultural Works.
395	
295	
385	
300	
600	Average, 383. Machine Shop.
325	
305	
465	
385	
425	Average, 487. A Blacksmith.
595	
565	
460	
395	
495	Average, 490. Saw Manufacturer.
525	
575	
310	
540	
665	Average, 536. Plow Works.
590	
575	
470	
410	
695	Average, 549. File Works.
575	
595	
750	
695	
750	Average, 728. Edge Tool Manufacturer.
705	
740	
1,150	
325	
300	Average, 740. Saw Manufacturer.
1,250	—Not hardened through.
675	
935	
870	
910	Average, 925. Edge Tool Manufacturer.
885	
1,025	
1,010	
800	
1,010	Average, 971. Steel Manufacturer.
1,170	
865	
1,025	
1,240	—Not hardened through.
735	Average, 987. File Works.
1,060	
875	
1,365	
1,100	
1,325	Average, 1,223. File Works.
1,165	
1,160	
1,000	
1,525	Not hardened through.
1,550	
1,015	Average, 1,231. Edge Tool Manufacturer.
1,065	

Excessive high-breaking strength (such as 1,500) indicates usually that the steel has not been hardened through.

My object in this was to get the probable average results of practice in the different shops, and not to discredit or praise any concern.

The table speaks for itself.

In conclusion, therefore, knowing full well that such small differences in heat produce such radical results, I have for the last year and a half hardened all my work at a practically uniform temperature, and during the last eight months used my thermo-pyrometer in practical everyday work with the most gratifying results.

Dayton, Ohio.

The Mechanical and Electrical Regulation of Steam Engines—II.*

By John Richardson, M. Inst. C. E.

Electrical Regulation. — The conditions which obtain for regulating engines driving dynamos are not quite the same as those for maintaining a constant speed in other machinery. If the electric current produced by the engine is employed to control its speed, it then becomes possible either to run the engine at a practically uniform speed in connection with a perfectly compounded dynamo, or to run it at a varying speed, maintaining either a constant difference of potentials with a varying current, or a constant current with a varying difference of potentials. Further, by utilizing the changes in the current to control the engine, it is not only possible, but quite easy, when the load is suddenly decreased, to effect what is impossible with a speed governor, viz., to shut off for a time the whole of the steam supply before the engine has had an opportunity of increasing its speed, and thus to deprive the engine of steam until its speed has fallen to just what is necessary for the diminished load, the steam supply being gradually increased until exactly sufficient for the load is supplied. Conversely, when the load is suddenly increased, and before the engine has had time to diminish its speed, the fullest supply of steam is given, and only then diminished to an amount corresponding with such increased load.

In Figs. 22–28 are shown a number of appliances which have been devised and tested by the author for the electric regulation of steam engines. Fig. 22 shows the direct drive of a governor by electricity. The two small magnets under the valve were intended to act as weights to close it, should the current be broken in any way and thus stop the engine, these being, of course, held out of position during the time the current is passing. In another form of governor, Fig. 23, there is no solenoid in direct connection with the valve, and only a small one, *E*, moving a light lever, at the end of which are two platinum points. This lever and the fixed points *A* and *B* are so arranged that when the lever is in contact with the upper point, the small motor *C* is caused to revolve, and by means of the crank lever *F* the valve is closed, and, of course, the reverse action takes place when the lever is in contact with the lower point. By this means it was thought that, as the solenoid at a certain intensity of current must be maintained in one position, when this intensity was arrived at the lever would remain at rest. Careful tests, however,

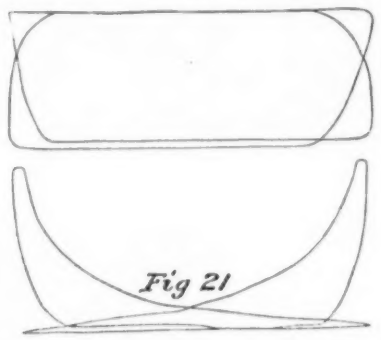


Fig 21

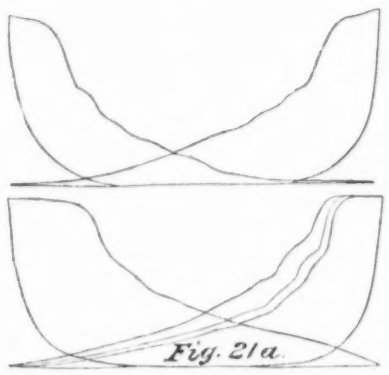


Fig. 21a

show that this is not so; however small the time occupied in making and setting the motion to work, it is enough to cause the engine to vary its speed too much, and the result is persistent hunting.

Fig. 24 illustrates a very simple arrangement, in which the equilibrium valve *A*, having a spindle projecting through a stuffing box, is pressed upwards by the steam with a force due to its unit pressure multiplied by the area of the valve spindle, say 15 pounds, and is held down by the short arm of the lever *B*, which has a ratio of 10 to 1, so that the force required is 1 or 2 pounds. The electric current circulating in the two solenoids *C* holds up two iron cores weighing 10½ pounds, and a very slight variation in the current tends to cause a considerable alteration in the position of the cores, especially when they are placed at the position of maximum effect, as in Fig. 24. It is remarkable how slight a movement of the valve is required to effect the regulation. Very careful experiments have shown that for an engine working up to 25 horse-power, with equilibrium valves of 2 inches diameter, it required to be raised only 0.003 inch from its seat to run the engine at full speed unloaded; and it needed to be raised only 0.031 inch to run the engine at its full power—the variation or actual lift of valve being thus only 0.028 inch, and, as the ratio of the lever is 10 to 1, the amount of movement of the solenoid cores is only 0.28 inch. When a load is put upon the engine, however, the fall is always much more than this, and occurs instantaneously, and before the engine has had time to diminish its speed. The valve is thus opened for a few seconds three or four times as wide as in its normal position, until the engine has received its full extra power; the solenoid then rises to nearly its former position. The reverse action takes place when the load is thrown off; the governor, simultaneously with the reduction of load, closes the valve entirely, and keeps it closed until the momentum is so far expended that the engine slightly slows, when the valve is gradually opened just enough for the reduced load. The action is instantaneous and direct, and there is no hunting. This apparatus is suitable for comparatively small engines, say up to 50 horse-power, but when large powers have to be regulated by a throttle valve, it is not economical enough in steam, and the valve would need too large a solenoid to control it within narrow limits, and would absorb too much current.

Figs. 25 and 26 show other forms of governor, with automatic arrangements for stopping the engine in case of failure of the electric current. In Fig. 25, which was the first form used, a heavy weight *A* is held up by an electro magnet *B* so long as the current is passing, but is released on the current stopping, when the lever *C* falling upon the valve spindle instantly closes it. The spring *D* and the weight *E* were for regulating the solenoid to the exact quantity or intensity of current required, as was also the lever *F*, which, passing over the contacts *G G G*, disconnects one or two of the coils out of circuit. A simple way of stopping the engine is shown in Fig. 26, where the weight of the solenoid cores is used to close the valves on breakage of the current, acting through the lever *A*. While the solenoid is active, the regulation is effected through the lever *B*, *A* moving idly, but the instant the current is broken, the cores fall, the lever *A* presses upon the valve stalk through the plunger *C*, and this is free to close, because the small end of the lever *B* works in a slot in the spindle with clearance upwards, all of its work being done, and its only contact being on its lower edge.

The type of valve gear illustrated in Fig. 27 lends itself admirably to electrical control. As the power required to move the governing lever *A* is practically nothing, a small solenoid and slight current is sufficient to effect the entire control of engines of 800 to 1,000 horse-power. While any current is passing through the solenoid, the engine is under perfect control, but should the current be broken from any cause, the cores *B* instantly drop, when their weight depresses the lever *C* and raises the lever *A*, as shown in Fig. 27.

Instead of this arrangement, a speed governor can be used in connection with the electrical governor, so arranged that it does not come into action until the speed has been increased by a certain percentage. This plan also is shown in Fig. 27. This method of governing electric light engines has been adopted in some important installations, and is very useful when an engine has to be used for sawing or pumping in the day, and for electric lighting at night.

Table II. shows some tests of the solenoid and throttle valve governor made by Prof. Silvanus P. Thompson some years ago, and, so far as the author is aware, every electrical governor made has continued in use up to the present time—the repairs and wear and tear being inappreciable, nothing being required beyond an occasional grinding of the valves.

Tests recently made of a pair of large engines with the solenoid working the trip gear show that, after eight years' use, they are practically as good as new. One of the bobbins had in this case short circuited on the brass flange, causing the wire to heat. A more recent method of construction by winding the solenoid upon a vulcanite instead of upon a brass and copper insulated hollow collar has prevented this. In connection with this governor a small resistance box is usually supplied. This is put into circuit with the solenoid, and by its means the amount of current passing through it can be regulated to a nicety, and the speed of the engine adjusted to exactly what is

* From "Proceedings of the Institute of Civil Engineers." Condensed by and for the American Machinist.

required. Once adjusted, with the same intensity of current, the speed will be modified to maintain the intensity.

In an electric installation covering a large area there is a definite loss of pressure in the mains on account of their length. If, however, a wire be brought from the center of the illuminated area and attached to the small solenoid *A*, Fig. 28, a constant intensity of current will maintain a constant position of the solenoid core, and will keep the lever *B* midway between two contact points. As soon as the slightest difference of pressure arises, not only does the main solenoid core rise and cut off the steam, but contact is made between *B* and *C*, exciting the small electro-magnet *E*, through the armature *F* pulling the spindle *G* with its revolving disk *H* into contact with the disk *I*, and through the gearing *K*, causing the contact lever *L* to move so as to cut off one or two of the resistance coils. By this means the main solenoid is intensified, and the speed is reduced until the lever *B* regains its mean position. It will be seen that the electric work, while very delicate, is insignificant in quantity, the real work being done by the driving cord *M* from the dynamo shaft. The two cells *O* and *N* are required to cut out the current should there be a tendency for the lever *L* to travel too far. In practice, however, these have never been needed. In fact, the action of the simple solenoid working direct on to the expansion gear gives such satisfactory results that there is no need of the relay and supplementary control shown in Fig. 28, and it is illustrated only to show within what very fine limits electric control can be carried if desired.

TABLE II.—TESTS OF THE SOLENOID AND THROTTLE-VALVE GOVERNOR.

Lamps.	Revs.	Amperes.	Lamps.	Revs.	Amperes.
17	146	10 2	11	96	10.2
17	144	10.2	11	92	10.3
17	143	10 1	11	90	10.3
17	137	10.2	11	89	10.3
17	133	10 2	11	85	10.5
17	119	10.2	5	70	10.0
16	133	9 9	5	60	10 5
16	132	10.1	0	30	10 4 10.6
16	120	10 2	0	24	11.0 11.2
11	107	10.1			
11	101	10.0			Unsteady*

*The unsteadiness noted when no lamps were in circuit is due to the passing of the sections of the armature past the field magnets at the slow speed, each section causing a pulsation of the needle of the ammeter.

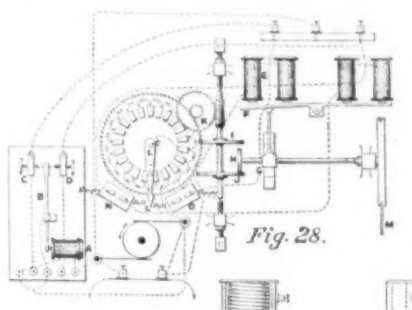


Fig. 28.

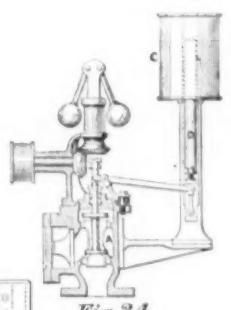
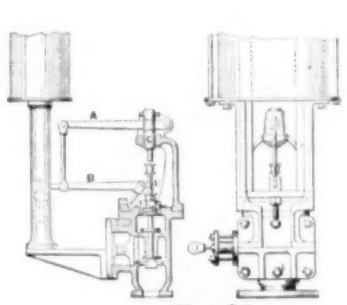


Fig. 24.



Figs. 26.

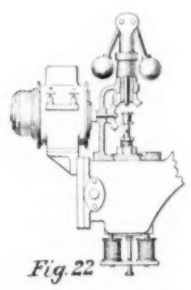


Fig. 22

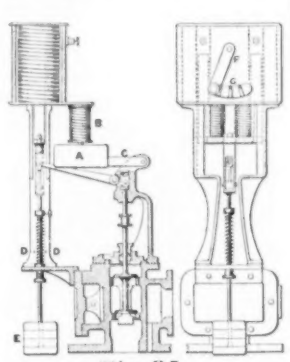
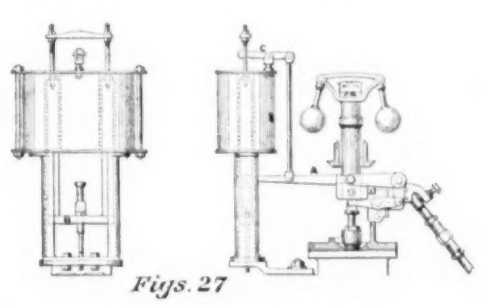
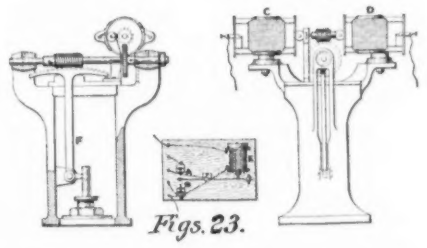


Fig. 25



Figs. 27



Figs. 23.

Manufacturers' Specifications for Structural Steel.

Below are given the manufacturers' standard specifications, governing the physical properties of structural steel, as adopted at the meeting of the Association of American Steel Manufacturers at Atlantic City, August 9th. The new specifications went into effect September 1, 1895.

(1) Steel may be made by either the open-hearth or Bessemer process.

(2) All tests and inspection shall be made at place of manufacture prior to shipment.

(3) The tensile strength, limit of elasticity and ductility shall be determined from a standard test piece cut from the finished material and planed, milled or turned parallel. The elongation shall be measured on an original length of 8 inches, except when the thickness of the finished material is $\frac{5}{16}$ inch or less, in which case the elongation shall be measured in a length equal to 16 times the thickness; and except in rounds of $\frac{5}{8}$ inch or less in diameter, in which case the elongation shall be measured in a length equal to eight times the diameter of section tested. Two test pieces shall be taken from each melt or blow of finished material; one for tension and one for bending.

(3*a*) Material which is to be used without annealing or further treatment is to be tested in the condition in which it comes from the rolls. When material is to be annealed or otherwise treated before use, the specimen representing such material is to be similarly treated before testing.

(4) Every finished piece of steel shall be stamped with the blow or melt number; and steel for pins shall have the blow or melt number stamped on the ends. Rivet and lacing steel and small pieces for pin plates and stiffeners, may be shipped in bundles securely wired together, with the blow or melt number on a metal tag attached.

(5) Finished bars must be free from injurious seams, flaws or cracks, and have a workmanlike finish.

(6) Steel shall be of three grades—Rivet, Soft and Medium.

(7) *Rivet Steel*—Ultimate strength, 48,000 to 58,000 pounds per square inch; elastic limit, not less than $\frac{1}{2}$ the ultimate; elongation, 26 per cent.; bending test, 180 degrees flat on itself without fracture on outside of bent portion.

(8) *Soft Steel*—Ultimate strength, 52,000 to 62,000 pounds per square inch; elastic limit, not less than $\frac{1}{2}$ the ultimate; elongation, 25 per cent.; bending test, 180 degrees flat on itself without fracture on outside of bent portion.

(9) *Medium Steel*—Ultimate strength, 60,000 to 70,000 pounds per square inch; elastic limit, not less than $\frac{1}{2}$ the ultimate; elongation, 22 per cent.; bending test, 180 degrees to a diameter equal to thickness of piece tested without fracture on outside of bent portion.

(10) Pins made from either of the above mentioned grades of steel shall, on specimen test pieces cut at a depth of 1 inch from surface of finished material, fill the physical requirements of the grade of steel from which it is rolled for ultimate strength, elastic limit and bending; but the required elongation shall be increased by 5 per cent.

(11) Eye-bar material, $1\frac{1}{2}$ inches and less in thickness, made of either of the above mentioned grades of steel, shall, on test pieces cut from finished material, fill the physical requirements of the grade of steel from which they are rolled. For thickness greater than $1\frac{1}{2}$ inches there will be allowed a reduction in the percentage of elongation of 1 per cent. for each $\frac{1}{2}$ of an inch increase of thickness to a minmum of 20 per cent. for medium steel and 22 per cent. for soft steel.

(12) Full size test of steel eye bars shall be required to show not less than 10 per cent. elongation in the body of the bar, and tensile strength not more than 5,000 pounds below the minimum tensile strength required in specimen tests of the grade of steel from which it is rolled.

The bars will be required to break in the body, but should a bar break in the head but develop 10 per cent. elongation and the ultimate strength specified, it shall not be cause for rejection, provided not more than $\frac{1}{4}$ of the total number of bars tested break in the head; otherwise the entire lot will be rejected.

(13) The variation in cross section or weight of more than $2\frac{1}{2}$ per cent. from that specified will be sufficient cause for rejection, except in the case of sheared plates ordered to gage, in which event there will be permitted an excess of weight over that corresponding to the dimensions on the order equal in amount to that specified in the following table:

TABLE OF ALLOWANCE FOR OVERWEIGHT FOR RECTANGULAR PLATES.

	Up to 75 inches wide. Per cent.	75 to 100 inches wide. Per cent.
For plates ¼ inch thick.....	10	14
" " $\frac{5}{16}$ " "	8	12
" " ⅜ " "	7	10
" " $\frac{7}{16}$ " "	6	8
" " ½ " "	5	7
" " $\frac{9}{16}$ " "	4½	6½
" " over ⅝ inch thick..	3½	5
" " ⅝ inch thick.....	4	6

SPECIFICATIONS FOR STRUCTURAL CAST-IRON.

(1) Except where chilled iron is specified, all castings shall be tough gray iron, free from injurious cold shuts or blow holes, true to pattern and of a workmanlike finish. Sample pieces 1 inch square, cast from the same heat of metal, in sand molds, shall be capable of sustaining on a clear span of 4 feet 8 inches, a central load of 500 pounds when tested in the rough bar.

Belts and Belt Lacings.

BY TECUMSEH SWIFT.

I was much interested in the tests of belt lacings described and illustrated in the AMERICAN MACHINIST September 5th. Nearly all of the article could be read in the pictures, and that is the kind of reading best adapted to my habits. Of course, testing the belt by a steady pull is not a fair reproduction of the conditions to which a belt is subject in practice, and the indications of such a test may not be accepted as conclusive; still, I think that to a certain extent and on some points the evidence offered by these tests is of considerable value, and that we may put considerable confidence in what they tell us. There is very strong evidence offered about the character of the holes for the lacings, showing that the hole that is made with an awl, although theoretically and actually removing no material from the belt, still is, in fact, the beginning of a tear which the lace is very apt to take advantage of and extend, while the round hole cut with a punch would give a good bearing for the lace and leave the strength of the remainder of the belt unimpaired. It is a good thing to have this testimony against the belt awl. Although I do not remember to have ever known the belt awl used for all the lace holes of a belt joint except in rare emergencies, I have certainly known the ends of belts very seriously damaged by awl holes. A small awl hole seems to be the best known means of securing the end of a belt lace, but such holes are almost invariably put in haphazard and without any consideration of the future of a belt. Nearly every new belt has to be taken up after running awhile, and then the trouble begins about the awl holes. No matter how the end of the belt may be cut off, it will generally happen that the awl holes remaining will be so located as to interfere with the punching of the new lace holes, and those holes will have to be punched in a more or less irregular way, and there will always be more or less trouble afterward about the location of the holes and the unnecessary weakening of the belt. There are writers who have undertaken to tell how long a belt should last before it is worn out, but as a matter of fact a belt rarely wears out or gets a chance to wear out. It gets used up at the ends by continual mutilation with the belt awl, or else it begins to weaken and tear from a species of dry rot. I have known few belts in my lifetime worn out, while I have known hundreds of belts get rotten and brittle and lose all their strength and become generally weak and worthless. This has sometimes been attributed to smoke and sometimes to injurious belt dressings, but neither explanation would save a belt.

After the evidence about the awl holes, we should not be in the least surprised at the bad showing made by the metallic belt fastenings. The great argument for them is that they do not remove any of the material from the belt, and that therefore they do not weaken it, while the fact is that they have all the vicious effect of the belt awl upon the belt with the awl left in. The prongs of the metallic fastening are better qualified for and more effective in slitting their way through the ends of a belt than a belt lace could possibly be. Those who have had the most experience with belts are most pronounced in their condemnation of all metallic fastenings.

The hinge-joint styles of belt lacings are beautiful examples of wasted ingenuity. It is not claimed by anyone that the hinge-joint mode of belt lacing is any stronger or more lasting, or in any way better than other lacings except for the hinge, and anyone must know both from reason and observation that there is no possible use for the hinge when the belt is in use. Any laced belt, with no matter what style of lacing, is much more flexible at the joint than anywhere else, so what could be the use of the hinge? And the belt in going around even a small pulley, if it needs a hinge anywhere needs to be all hinges and not in one spot more than in another. The strain of the lace over the sharp corner of the belt must cut or weaken it and cause it to wear sooner than a lace which lay flat to the surface of the belt. This cutting or wearing of the lace by the end of the belt in running would not, of course, appear in a simple tensile test of the joint.

I need not say a word to any reader of the AMERICAN MACHINIST about the important

ENGINE REGULATORS.

service performed by belting in connection with the operating of most lines of machinery. Machine shops have their full share of belting, and every machinist has his belting experience, and he should not be easily fooled upon the subject. Considering the great and responsible duties of belts, the trouble and expense of maintaining them in good order I consider remarkably small; and where belts are properly adapted to their work, properly laced and properly maintained in every respect, the further trouble often experienced in connection with them is very apt to really belong somewhere else. They have a way often of telling of derangement in shafting or machinery, and by their recalcitrant action insisting upon repairs and adjustments that would otherwise be long delayed. Squeaking journals and slipping belts are mechanical police, and their mandates can never be ignored for long.

Mr. Flint's No. 3 and No. 9 are excellent styles of lacing, and if the lace is good and the ends are properly fastened should last a long time. Laces or belts are not generally strained to anything like their ultimate strength, and they certainly should not be. Mr. Flint makes the tensile strength of 4-inch single belt after five ¼-inch holes are punched in it 2,065 pounds, which is probably a fair average. If 600 feet of one-inch belt per minute transmit a horse-power, the driving pull will be 55 pounds, and on a 4-inch belt at the same speed it would, of course, be 220 pounds, or less than one-ninth of the ultimate strength. This is not the entire strain that comes on the belt, as some tension is required on the slack side to secure proper adhesion to the pulleys, and the driving pull of the belt will only be the difference between the tension of the tight and the slack sides, while the total pull on the tight side of the belt will be the actual driving pull plus a strain equal to and balancing that which is on the slack side of the belt. Horizontal belts with both pulley and belt surfaces in good condition, and with the slack side of the belt upon the top, often run with very little addition to the actual driving pull. Any tension in addition to the driving pull of the belt is, of course, so much more strain on the belt and also causes so much more friction in the journals, and should be avoided as much as possible. Much more attention should be given to the condition of pulley surfaces and also the belt surface, and to the location of pulleys with relation to each other.

Some Reasons Why Bearings Heat.

By Peter H. Bullock.

On general principles a smooth round shaft should revolve in a well-made and lubricated bearing without heating, provided, of course, that there is not an excessive pressure on the carrying surface. An excessive pressure, however, is more often brought upon a bearing by other causes than simply the weight of shaft and pulleys, generally by too tight belts or by belts pulling at some angle that the bearing is not designed to resist. I will describe several cases from my own experience:

A shaft running in self-oiling reservoir boxes was belted to a shaft directly above, and in a short time the bottom bearing began to heat. The cap bolts were loosened and it ran worse than before. A close examination showed that the cap had been held up by card-board liners, and that the belt was tight enough to carry the whole weight of the shaft, and that there was a clear space under the shaft where the fibrous material was supposed to keep the shaft well oiled. The caps were adjusted so as to keep the shaft in its place, and there was no further trouble.

A 7-inch bearing, of which Fig. 1 is a sketch, had run all right for several years, but was finally found to be slightly out of level. It was raised and a strip of metal slipped under the center, the end bolts 1 and 2 being screwed down to the sole plate. It is but fair to say that this bearing was especially light in section of metal below the shaft, and that the end bolts should not have been screwed down. Immediately on starting up the bearing began to heat, which was caused by the reduced area of contact, the bolts pulling the sides *B' B''* apart and bringing the whole weight on to a narrow support at *A*. Pieces were put under each end near the bolts and the center one left out and it began to heat sooner than before. This was caused by the weight of shaft springing the center down and binding at

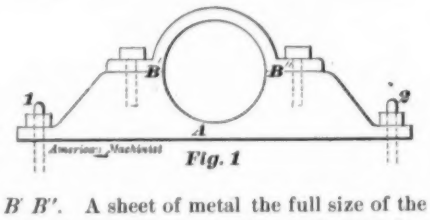


Fig. 1

B' B'. A sheet of metal the full size of the bearing was then put under, and there has been no trouble since.

An engine was set up for transmitting about 90 horse-power through a line of shafting and was run for half a day at full speed but without any load, and there were no signs of heating anywhere. When the work was put on, the bearing on the line shaft nearest to the receiving pulley began to heat and finally melted out. The bearing was nicely repaired and the same thing happened of running all right without any load and heating when work was put on as before. I was consulted and gave as an opinion that while the bearing was all right for the weight of the shaft pulleys and belt that it was not large enough or of proper design to resist the extra side pull caused by the load. The owner could not see how that could be, for, as he said, "the belt was just so tight and the work was twisting the shaft around." I had to do some very primary experiments to convince him that the bearing was simply a fulcrum, with the rim of the pulley as the lever, and the total power transmitted the weight moving the lever. In this case the bearing was designed for carrying a load in a vertical direction, while the belt pulling nearly horizontally brought the friction on to the edge of the bearing and its cap, where there was a ridge of cast-iron flush with the babbitt, and which, of course did not fit the case either in shape or in quality of material. A specially designed bearing with a babbitted quarter block prevented any further trouble.

As to oiling devices for bearings, it is probable that the pressure system through pipes and sight-feed cups is the best and surest means for constant and satisfactory lubrication of heavy journals. This permits the oil to be collected and filtered for further use—a matter of no small economy in large establishments. For lighter work self-oiling is all right if properly looked after. I have charge of some in clean shops that have not been taken apart for fifteen years, nor oiled but twice a year during that time. The shaft runs 150, is in line, level, and is not much loaded with pulleys or belts. Under some other conditions, however, I have some that have to be given new capillary material every three months, and fresh oil much oftener. For heavier shafting and higher speeds I prefer ring or chain oilers, but these also need attention, for if sediment is allowed to collect in the reservoir it will cause trouble from the dirt being carried to the bearing, or from the ring sticking in the thick matter, when, of course, there will not be any oil, good or bad, carried to the shaft, and heating must ensue. The same trouble will sometimes occur from using a too heavy oil, or in cold weather when some oils, especially if they contain any animal mixture, become thick.

Sometimes a case of this kind will correct itself, for as the box warms up the oil becomes thin, allowing the ring or chain to begin to work, and thus avoid further heating. Some always use a grease cup on bearings for this very purpose of melting in case of heat. If these are used with ring or chain devices they are almost sure to cause the trouble spoken of above by making the oil too thick to allow the rings to operate. For these reasons I prefer to depend entirely on the rings and to use nothing but a good grade of mineral oil.

The Horse-Power of Steam Boilers.

By Charles A. Hague.

The term horse-power is hardly a proper term to apply to anything that is accomplished by a steam boiler, and the term is generally used in this connection to designate the *amount* of boiler required to furnish steam to some sort of steam engine of a certain stated horse-power. That is, the engine for whatever purpose it is used, is capable of developing, when supplied with sufficient steam, a certain number of foot-pounds of work per minute, and after it is determined at what rate of steam consumption the engine is to be calculated, according to its grade or type, boiler capacity sufficient to evaporate the required amount of water into steam must be provided.

Now if all engines were alike in their consumption of steam, the calculations for boilers in terms of horse-power would be simple enough, but when it is considered that the different types of steam engines call for steam in amounts varying from 150 pounds per hour for each horse-power developed, down to less than 12 pounds per hour per horse-power, the margin liable to be realized or to be needed can hardly be imagined. And as if this was not variety enough, the difference in the efficiency of various designs of boilers must also be considered, and the difference in the heat value of fuels. The process then, it would seem, is to decide as nearly as may be, the consumption of steam per horse-power per hour by the proposed engine, and then to calculate upon a boiler which, with the available fuel, will produce the required gross weight of steam, and if this is recognized as the fact, then the term horse-power certainly stops at the engine.

It seems to the writer that the measure of boilers should be stated and considered in terms of "boiler capacity," that is, the capacity to furnish *quantities* of steam regardless of what it is to be used for. The expression "horse-power of a boiler" is misleading and meaningless; for example, what connection is there between the term horse-power, and the amount of steam required to warm a building? The question of power does not legitimately enter into the matter of utilizing the heat, latent and sensible, of steam for purposes of warming, boiling, and kindred uses.

Coal is burned in the boiler furnace, and heat is produced. The steam formed in the boiler is the vehicle for conveying whatever percentage of the heat of the burnt coal the boiler happens to realize and transfer to the water. When the steam reaches its destination, it gives up what heat it may, under the conditions and for the purposes desired, but up to the point of the steam leaving the boiler, and in many cases afterwards, there is nothing in all this to represent in the tangible manner necessary to the use of the term power, the product of force and motion.

The tendency of the times is towards higher steam pressures, higher ratios of expansion, higher economy, consequently more complicated machinery and more expensive boilers. The engineer must therefore figure more closely, both because the higher grade of engine demands to be brought closer to the conditions, and also on account of the fact that if the high-grade boiler is the more expensive one, the *quantity* of boiler must be kept as closely as possible to the actual demands, proving most beautifully that the moral or mental effect of economical methods leavens the entire evolutionary mass of modern steam engineering.

This country is broad and contains many kinds of experiences and many sorts of coal; also, many boiler makers in the East who sell boilers in the West, and many boiler makers in the West who sell boilers in the East. The terms East and West here used imply differences in fuel principally, and the term experiences implies that the boiler makers brought up on anthracite coal, so to speak, misjudge the radicalism of bituminous coal, and the bituminous coal boiler makers miscalculate the ultra-conservatism of the anthracite coal. When the above erraticisms are coupled to the facts that compound engines may, by good design, construction, and high steam pressure, reduce the steam rate as low as 14 pounds per hour per horse-power, or may hold it up as high as 20 pounds, by the opposite qualities and conditions; when triple engines vary the item of steam consumption all the way from 11 pounds to 15 pounds, and quadruple engines might range from 10 to 12 pounds, it is plainly to be seen that the term horse-power as a general term applied to boilers begins to approach the boundaries of the absurd.

We make a trial run with a steam engine and boiler, using the boiler incidentally to generate the steam, and note how much by weight the steam is which passes into the boiler in the form of water; from this the actual steam rate of different types of engines may be known, and from this we can determine at any time from the record how much weight of steam per hour must be supplied for any certain type and size of engine.

Now, coming to the boiler, all real ideas of horse-power disappear, and the question is brought down to quantity, or weight, of evaporated water, or steam. In estimating the necessary weight of steam we must know about the draught, which may be assumed at a certain force and measures taken for securing it; that is a good *controllable* starting point, and really a very necessary one. Assuming that the draught necessary to burn a certain amount of coal per square foot of grate is to be had; or, having provided for supplying an amount of oxygen that will economically develop from the combustion of the fuel a certain determined number of units of heat, this means that the chimney must suit the locality.

The next thing to consider is that anthracite coal burns slower than bituminous, although we may assume that the total heat units per pound of coal will be about the same, considering the variation in both kinds of coal, and this means that the grate surface must vary to suit the coal. And the ratios between the rates of combustion of different coals will establish the varying proportions of grates to produce any certain number of heat units per hour. Again, when actually burning coal in a boiler furnace, it is found that although the total heat units per hour may be the same according to analyses of the coals, the real efficiencies of the coals differ, probably from some variation in amount and quality of the volatile gases, and this means that the extent of heating surface necessary to absorb the number of heat units wanted to produce any determined weight of steam per hour from different kinds of coal, will also vary. In fact, even among the Western bituminous coals, there is sufficient difference in distillation, coking and final incandescence, to render widely different treatment necessary in the way of furnace and draught arrangements. The boiler efficiency is still another variable factor, but this can probably be assumed at 70 per cent.; that is to say, 70 per cent. of the total number of heat units, developed by the combustion of the coal, ought to be passed through the metal of the boiler and absorbed by the water.

The result of all of these variables is, that it is possible in furnishing steam for engines of equal horse-power, but of different classes or types, for boilers to vary in required steaming capacity over one hundred per cent., counting from the most economical engine only up to a compound requiring 20 pounds of steam per horse-power per hour. The number of types of engines could be easily extended so that the increase in required steaming capacity would reach 400 per cent and over. Add to these differences the uncertain quantities involved in qualities and combustions of fuels far apart, and we may well ask what chance is there of determining the "horse-power" of a boiler of itself with such numerous but perfectly legitimate variables in the equation?

None but American citizens are hereafter to be employed as draftsmen in the Navy Department.

Competition—Condensers—Cutting-Off.

By W. H. BOOTH.

An unrestricted competition devoid of the exercise of brains is bad for all concerned, but some competition appears to be necessary to human progress. For many years Liverpool has been the port for entry and departure of the American passenger traffic. There was no serious competition, and the result of this was that the dock authorities at Liverpool neglected their obvious duties to such an extent as to allow the low-water depth at the Mersey bar to shoal to only 11 (or was it 7 ?) feet. One result of this was that you might arrive at the Mersey bar just a minute too late to get over it, and after waiting a long time you got transferred to an old tug boat and arrived with your baggage six hours later than necessary at Liverpool. The obvious advantages of Southampton have resulted in the establishment of steamer lines from this Southern port and direct trains from London, and this competition it is to which we are indebted for the fact of the deep dredging of Liverpool bar, special train facilities for passengers, and now for a proposal to bring the railway to the dock side and dredge along the dock side so that the liners can discharge direct to the station. All these points have been plainly necessary in public opinion for years, but to bring this necessity home to the dock board and the railway people, it has been necessary to make a rival port of Southampton. Exactly the same process had to be gone through in respect of the excessive charges on the railways from Liverpool into the country, and the city of Manchester built a ship canal that has halved the cost of carriage on the railways whose managers declared their charges were already such as to be a loss. There was no physical necessity for the canal. The increased trade could have been dealt with by another line or two of rails at very much less cost; but the canal had to be made in self-defense, and now it is probable that both Birmingham and Sheffield will also obtain direct sea canals as a means to prevent themselves being crushed out by railway charges. I find that the spirit of competition —or, perhaps, I should say emulation—exercises a powerful influence in promoting steam and fuel economy, but this is more particularly marked in such places as are practically copies of other places. In the cotton-mills of Lancashire there is often identity of conditions in make of engines, number of boilers and other particulars, and if the fuel bill of one place differs widely from that of the others, there is to be found a reason for it. The engineers all strive to secure the best results. In manufacturing establishments of more miscellaneous description, more isolated and less easy to compare with others as to efficiency, the care devoted to the steam plant is far less in amount, and obvious wastes are allowed to run on for years unattended to. There is, of course, a limit to be placed upon the indiscriminate purchase of saving devices. A few of the chief means to economy, such as a condenser to a high-pressure engine, a feed heater, and so on, can hardly be applied wrongly. Their economy is too obvious to admit of argument where the conditions at all demand them, but such is not the case with scores of other things, and out of a hundred economies of five to ten per cent., it is obvious that not all can be applied in any one case. In the case of a fire bar, no possible good can be done by changing to a new type simply because you know for a fact that the new type effected a saving of seven per cent. at a place you hear about. It may be perfectly true that the bar did save that amount of fuel, but it is also equally true in all probability that the circumstances were quite different either in draught, grate area, fireman, fuel and rate of combustion, and your present bars may be seven per cent. more economical at your own place than would these other bars be. You must treat every case by its own conditions, and not let your better judgment be swamped by a salesman who can sail round three times and keep up a heavy fire of words before you have time to think. Never be persuaded to purchase anything off-hand. Have a lot of cards printed bearing words to that effect, and present one whenever you are being bluffed. You can think the matter over at leisure, when no one is talking to you, far better.

There is a border line between high-pressure working and condensing at which condensing ceases to be an economy. The same applies to many other nominal economies as the size of engine diminishes. If you have only a limited condensing pond you begin to save less by a condenser because the water gets too warm, and you may use more power to work the pump than the saving is worth; but sometimes in a case of this kind you can use a surface condenser of the atmospheric type, by which I mean one built up of a lot of tubes over which flow thin streams of water. The evaporation of this water by the breeze, the condensers being as much exposed as possible to the air and sometimes placed on the roof, secures a vacuum better than you will get from an ordinary but too small pond, and the amount of water they evaporate only comes to the amount of the steam condensed, so that an air condenser uses no more water than a high-pressure engine. If the expense of the air condenser is too great you can build a wooden tower and divide its upper part into a large number of vertical cells of rectangular form by means of thin boards. If into the bottom of such a tower you blow air by a fan and into the top you run the condensing water you will cool this as it flows over the boards in thin films to an extent that I have been told will equal a pond area 100 times the area of the tower base. The system causes some air to become dissolved in the water, but a little air in the feed water may be an economy. You get some power out of it when it enters the cylinder and expands, and there are good reasons to believe that a small amount of air does a good deal in preventing condensation of the initial steam in the cylinder.

Don't be hastily persuaded to add a cut-off slide to a plain small engine. It will likely cost more to run the engine afterwards than before. Cut-off and expansion within reason are good, but depend partly on the size of your engine for their effect. In a large engine with a steady load the day through, varying the expansion cannot possibly do much good for the few variations in power there may be during the day. Where the power varies from 980 to 1,010 horsepower a throttle valve is practically as good as an expansion valve that varies if you have good boilers and a five-pound margin of pressure. You can have the expansion valve but it may be invariable. If you can arrange for a superheater you will economize far more than with variable expansion. The reason why cut-off got so good a character was not because it was automatically variable but because it was a *cut-off* and not simply a throttle which carried steam of half the boiler pressure all along the stroke. That was where the loss came in. But the facts have been obscured until all the credit is given to the variability of the expansion where the power developed is practically a constant quantity. When, therefore, you take charge of a fresh plant first get it into as good mechanical order as you can, and put the boiler in such a condition as to work with the minimum grate surface and maximum fire thickness convenient. It is then time to look around to make changes that cost money, bearing in mind that because steam is a peculiar fluid and has critical states in which it exists as water or as steam with little provocation of change, therefore economies that figure out very well for some distance receive a very unexpectedly earlier limit in practice. Don't carry on too far along any line of even proved economy unless you can retrace your steps.

It is said that in a dictated order for materials for a railroad bridge, a stenographer made an error of a quarter of an inch in one of the dimensions, and it cost $28,000 to rectify it.

LETTERS FROM PRACTICAL MEN.

Making a Miter Gear Pattern.

Editor American Machinist:

In reply to Mr. Swift, in AMERICAN MACHINIST of September 5th, I would say it was not the intention to limit the method given for making the gear teeth to a miter gear, for it can be seen that it applies to spur gears and those at any angle, without saying so. I did not think it necessary therefore to make such a statement to any reader of the AMERICAN MACHINIST, and as the subject was miter gear patterns, of course, it was a limited subject.

Mr. Swift says: "Loose teeth must have a thin wing upon each side forming one-half of the bottom of the tooth space, so that they will require very delicate handling." Not so in such small pitches as given in my article, but when a coarse pitch is made a strip is secured to the run between the space, as shown in Fig. 1 at *a*.

As to the "ticklish job" referred to by Mr. Swift, of returning every other tooth to its proper place after being pared, and the filling up of the saw cut between each tooth,

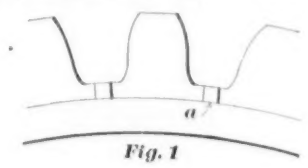


Fig. 1

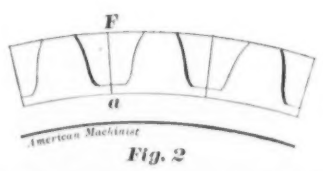


Fig. 2

I would say every other tooth can be located accurately again without the least trouble, and there is *no* saw cut to fill up between each tooth, as Mr. Swift imagines. For convenience I will quote from my article referred to on this point. "The blocks for the teeth are fitted on the rim as at *F*, all being glued together, but only every alternate one is glued to the rim. . . . Particular care must be taken when gluing not to allow any glue to get on the sides of the blocks near the rim, as at *a*, for instance."

The reduction of the drawing may be some reason why Mr. Swift did not see this point. The last sentence in my article shows that sawing between each block does not mean sawing down to the rim, but only to the bottom of the space of tooth.

Chicago, Ill. P. S. DINGEY.

The Radial Icicle.

Editor American Machinist:

If not too late will you allow me to make a remark bearing on that radial icicle ?

You have no doubt observed an occasional ardent bicycler spinning along in muddy weather, with shoulders down and head well forward, according to the best form, and have noticed the streak of mud flying from the rear wheel and landing on the man's back, and even on his hat, giving him very much the appearance of a brown squirrel with a large, bushy tail. Now, if these particles of mud do not leave the periphery of the rear wheel in tangential lines, how do they land on the rider who is in advance of the wheel and advancing with it ?

It would appear that fluids move from the center of a revolving disk toward the periphery in radial lines, but they leave the periphery in tangential lines, therefore icicles would naturally form in radial lines, but if melting would be thrown off at tangents.

Fort Wayne, Ind. HOOSIER.

The Scales at Watervliet Arsenal.

Editor American Machinist:

I notice in the AMERICAN MACHINIST of September 5th, in your editorial comments upon the letter signed "W. W.," that you express some doubts as to there being any facilities at the Watervliet Arsenal for weighing a load of 115,000 pounds within a limit of error of less than 25 pounds. I inclose you herewith a clipping from *The Iron Age*, which contains an article describing a scale built by E. & T. Fairbanks & Co., of St. Johnsbury, Vt., less than two years ago, for the Watervliet Arsenal.

The illustration shows the scale as it was loaded during the rigorous test to which it was put by the government officials, there being at that time three large guns on the platform in order to obtain a load equal to the full capacity of the scale.

The writer was in constant charge of the work of construction and setting up of this scale, and is, therefore, in a position to know something of its capabilities.

The minimum graduations on the beam are 10 pounds, but as is stated in *The Iron Age*, a reading to 5 pounds can easily be estimated by the eye.

The beam might just as conveniently have been graduated to read to 5 pounds, but as 10 pounds was as fine as the specifications called for, we fixed the limit at that figure.

As this scale is built on the same general principles as all Fairbanks railroad track scales, any question as to its accuracy would be equivalent to questioning the accuracy of all Fairbanks track scales, and as this company are shipping eight or ten of this class of scales per week, varying in capacity from 50 to 100 tons each, and no complaints are heard from them, it seems reasonable to infer that they are fairly accurate.

St. Johnsbury, Vt. F. W. TAYLOR.

[The scales referred to by Mr. Taylor employ the knife-edge principle, and our estimate of their limit of error when loaded to 115,000 pounds is slightly over .02 of one per cent. This, while it is not a small limit of error for an acceptance test, would, we think, be generally regarded as a small limit for weighings made on such scales after having been used for a year or more. We do not doubt that the scales in question are the best of their kind, but should hesitate to accept their weighings as correct within a smaller limit than that named, unless we knew that some extra precautions were taken. It is, of course, as Mr. Taylor says, reasonable to infer that these large scales are "fairly accurate;" but what is "fairly accurate" under ordinary working conditions ? We do not think it will be found to be within a limit of error of less than .02 of one per cent. But even assuming that the original delicacy of action obtained while the scales were under Mr. Taylor's charge were maintained, they would still not indicate anything smaller than 5 pounds, and nothing less than 10 pounds, except by estimation.—ED.]

Measuring Curved Surfaces—Measuring Distances Exceeding Length of Scale.

Editor American Machinist:

In your journal of the 5th inst., Mr. F. W. Clough discusses the defects of flexible scales when applied to measure curved surfaces.

When applied to measure a convex, such a scale will fall short of the actual length of the surface, and when applied to a concave surface it will exceed the actual length. This discrepency will vary as the thickness of the scale and the curvature of the surface vary. These facts are well known by those who have frequently this kind of work to perform, but many who have it occasionally to do seem to be ignorant of the principle.

I desire to supplement the subject by noting the difficulty of accurately measuring a distance that is somewhat greater than the length of the scale used to measure with.

Different persons will measure the distance differently, because the factor of personal equation intervenes.

Given a two-foot standard scale, I have never seen the person who could accurately lay off twenty feet with it when used in the ordinary way. Neither have I seen the measurements of that distance by two or more persons with such a scale that would agree with each other.

When distances exceeding several times the lengths of the scales at hand are to be worked to, it is good practice to lay off the

lengths on a substantial white pine batten after the manner of laying off the base line for a trigonometrical survey, that is, by having at least two scales abutting their ends, and advancing each alternately until the required distance is attained. Let the measurements so laid off be the standard for the work. I. MCKIM CHASE.

Washington, D. C.

Folding Band Saws.

Editor American Machinist:

One of your correspondents of July 11th gave an explanation of the process of folding a band saw which is hardly as clear as the simple nature of the operation admits of. Fig. 1 is the most usual form in which we see these saws. If the points *A* and *B* be grasped in the hands one hand can be moved to the right and the other to the left, producing the form in Fig. 2. The

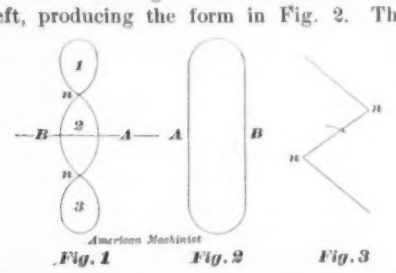


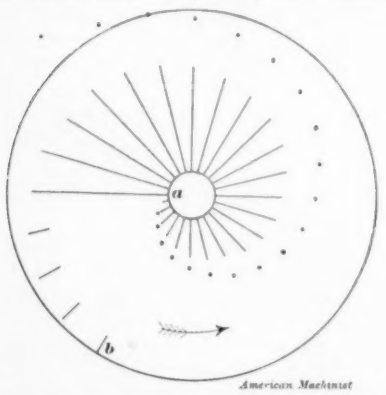
Fig. 1 *Fig. 2* *Fig. 3*

most convenient position for the saw to be held is directly in front of the folder and nearly vertical. The nodal points *n n* are weak to resist bending, though they don't "look" it. By giving loop 2 a quick turn around the line *B A* the inertia of loops 1 and 3 will cause the loops to take the form in Fig. 3. The hands being withdrawn the whole affair just "rains down" to the floor all folded. SUPERANNUATED.

Monkey Wrenches and Icicles.

Editor American Machinist:

The last number of the AMERICAN MACHINIST set me thinking on two or three points. One point is generally as much as I can attend to, and I can only speak of these one at a time. There is the monkey wrench question first of all, and that is about my size. I suppose that there are fellows still constantly getting into the trade that do not know enough to put the wrench on to the nut the right way so as not to spoil the wrench, and it is necessary to keep telling these things over and over again for the benefit of this benighted class, but I do not think that there can be much benefit in it after all, for if a fellow does not catch on to a point like this for himself he is not likely to turn out much of a mechanic, and it would be no great loss to turn him out of the shop. But if we do undertake to tell a thing of this kind we ought to tell it pretty straight. I have always had an idea that the real objection to putting the wrench on



the reverse way was in the strain that is thrown on the fixed jaw, while Mr. Woolson tries to make out that it is the movable jaw that has to suffer. I know that I have seen a great many wrenches with the fixed jaw bent back, and I know that wrench makers have made wrenches with what in church building would be called a buttress at the back of the wrench, and sometimes the wrench is made with the whole shank made deeper from the head down to a little beyond the full opening of the jaw. In Mr. Woolson's Fig. 1 with the wrench put on the wrong way over a hexagon bolt head, and a little slack to the jaw, the angle of the bolt head that is next to the movable jaw is almost exactly in line with the center of the screw, and the thrust must come on the screw more than anywhere else, but the other angle of the bolt head against the fixed jaw of the wrench bears pretty well out to the end of the jaw and must have quite a leverage upon it. I have known a great many wrenches spoiled by bending the fixed jaw back or breaking it off, but the loop of the movable jaw is not often broken, and how the strain can be in the direction of the arrow shown in Fig. 1 is more than I can understand.

Icicles I do not know much about, at least in a scientific way, and certainly not about radial icicles. It does seem strange to me, though, that anybody should go to work and "discover" that water running from a shaft and along the face of a revolving grindstone should run and, if the weather is cold enough, freeze in radial lines. I have seen too many oil streaks on pulleys and gear faces to expect to see them any other way than radial, and if anybody is disposed to make a wonder of the radial icicle I suppose the same individual would be puzzled to suggest any more likely form for it to take. The radial icicle, it seems to me, may teach us something about centrifugal force. I suppose it must be true, as was said in "The Draw Cut" article in the AMERICAN MACHINIST two or three weeks ago, that nothing ever moves in two directions at the same time. Then when anything is moving in a circular path it is at any infinitesimal portion of its movement actually moving in a straight line, and the circular movement is the result of some other force acting at right angles to the line of its established motion, and constantly shoving or pulling it in toward the center. We always reckon centrifugal force as radial, and that is the force that opposes the rectangular force that is constantly crowding in toward the center when anything is moving in a circular path. When this force, the crowding-in force I mean, ceases to act, the opposing force, or the crowding-out force, has it all its own way, and, of course, it pushes in just the same line that it has been in the habit of pushing, which is a radial line. But while the line of motion is radial with regard to the revolving wheel it struck me to see what it would be with regard to things that are not moving, and I have taken the trouble to lay it out for my own satisfaction. Supposing a drop of water on the face of a grindstone to start at *a* on the inner circle of my sketch and move outward along a radial line at a uniform speed, then the lengths of the lines one after the other would show the actual path of it, and when it got to the outer circle at *b* it would not seem so strange that its path after that were a true tangent. If the rate at which the drop moved along the radial line was not uniform, but steadily increasing, then its path might be represented by the dots, and it would get to the outside quicker, but still travel all the while in the radial line. I cannot speak of any more points in this letter.

TECUMSEH SWIFT.

Oiling Bicycle Bearings.

Editor American Machinist:

I was much pleased to see Mr. Grant's communication in your issue of August 29th, regarding the oiling of bicycle ball bearings, as it agrees with both my theory and practice since the first introduction of the old high wheels, and I have never before found anyone who has agreed with me that oil is worse than useless in a ball bearing.

When we have a load to move, such as a heavy piece of machinery on a floor, we find by placing a few rollers underneath, that much less power is required; but would anything be gained by greasing the rollers? I have never tried it, but I imagine that the result would be such a collection of dirt as would at once discourage the practice. It is true that there is a slight rubbing friction in a ball bearing of one ball against the next, as their surfaces run in opposite directions, but the pressure between them is so slight that wearing or cutting is not likely to occur when no oil is used.

I prefer to run my ball bearings dry.

Eddystone, Pa. W. P. ANTHONY.

Editor American Machinist:

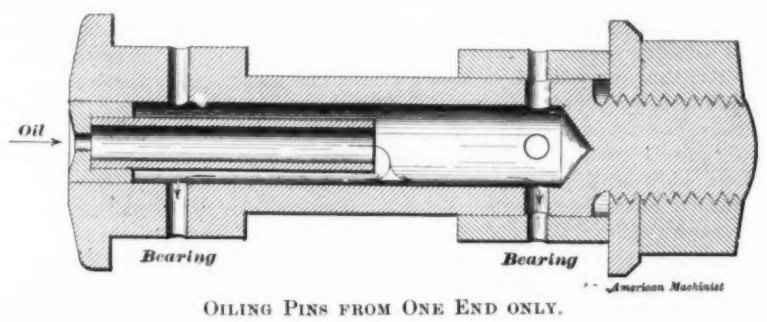
In the issue of your valuable paper of August 29th, I see a very interesting article on the valve subject. Some years ago I had the same experience on a heavy vertical bar with ball bearings, and my trouble lasted until I stopped oiling; from that day on there was no trouble whatsoever, the bar rolled free, right along, and my bearing was clean. Therefore I agree on this point with Mr. Thomas Grand, and will say that as long as you keep your ball bearings well adjusted on any bicycle, you don't have to oil them any more than a railroad company has to oil its rails to save the car wheels, for both roll, and if oiled both will slip, and the oil will accumulate dust, making a good grinding paste, and then actually your bearings begin to wear flat spots, and the oil is the cause of it all. CHAS. FORTH.

87 North Arlington Ave., East Orange, N. J.

Oiling Pins from One End Only.

Editor American Machinist:

A special pin in a fly-wheel governor of the Straight Line Engine Co. has a bearing at each end that requires to be oiled from one hole, and that at one end of the pin. The annexed illustration shows how that is successfully accomplished. The pin is bored very nearly through its entire length; at the far end of the bore there are



OILING PINS FROM ONE END ONLY.

four holes leading to the bearing, and there are also four similar holes, near the out end, having similar outlet. To insure equal distribution of the oil to both sets of holes, there is a smaller concentric tube leading from the accessible end and terminating at a point midway in the length of the pin. The oil introduced at one end flows to the middle of the large bore hole, and thence goes in both directions to each set of holes.

G.

Important New Patent Office Rule.

Editor American Machinist:

Heretofore inventors have been accustomed to make use of the two years' time in which to prosecute an application before a primary examiner. The new rule allows only six months, and went into effect April 15, 1895. Pending cases will be affected as though the last office decision were upon that date; therefore, all applications which were pending before that date should be amended or argued before October 15, 1895.

This is the essential feature of the rule, and important at this time, because of the near approach of the limiting date, and the undersigned takes this opportunity of informing probably hundreds of inventors who may be depending upon the two-years' limit. EDWARD P. THOMPSON.

5 Beekman street, New York.

A Good Chuck Wanted.

Editor American Machinist:

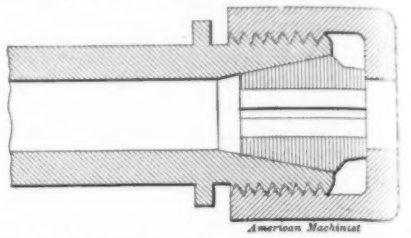
Being particularly interested in the use and manufacture of turret machinery, I am constantly finding the want of a really good chuck for holding bars.

An ideal chuck for my work should admit bars up to, say, 1¼ inches or 2 inches diameter, should be *small* in diameter (say, 6 inches), should not project more than an ordinary chuck beyond the lathe bearing, and should have sufficient power to hold a bar of 1-inch black machinery steel, while a 1-inch Whitworth solid die is run up.

Further, it should be true enough to admit of reversing a stud after one end has been threaded, and cutting the second end reasonably true with the first.

I do not expect to get the ideal chuck, but I would like to hear if any of your readers can help me to something approaching the above. The only chuck I know which approaches this is the old English cone chuck.

This has the necessary power, size and accuracy, but it needs a lathe spindle, hard-



ened and ground inside the cone, and also a separate set of jaws for every size of bar, and it needs a spanner about 3 feet long to tighten it, and, worse than all, some very substantial and unwieldy method of locking the lathe spindle while it is tightened and released. ENGLISH TOOL MAKER.

Pressure on Crank Pin.

Editor American Machinist:

Replying to the letter of Mr. G. W. Scott, in the issue of August 29th, would say that in presenting the subject of pressure on the crank pin in the way that I did, one object was to call the attention of young engineers to the fact that it is better to investigate such matters, and look at them from more than one standpoint, rather than to accept every statement that they hear or read, without question.

More than five years ago an article appeared in one of the mechanical papers over my signature, which was written to prove that a force applied in such a way as this acts on the circular body according to its diameter, and not its circumference, therefore it is plain that the views of Mr. Scott and myself are identical up to this point, but one reason which makes it possible for a difference of opinion to exist is as follows: Mr. Scott says that the pressure on the oil will vary per unit of contact surface, but will be the same on every square inch of projected area, and mentions 900 pounds as a desirable limit to this pressure, but this is often exceeded and no trouble caused thereby.

Take, for instance, the case of an engine well known to the writer. When it was first built its cylinder was 16 inches in diameter, and the crank pin was 5½ inches long and 3½ inches in diameter. The unbalanced pressure on the piston was 83 pounds per square inch, or 16,683 pounds total. How much of this was absorbed by the piston, the stuffing box, and the guides, I am unable to state, but probably at times it was nearly all effective. Multiplying the length of the pin by its diameter gives us 18.37 square inches projected area. Then $16{,}683 \div 18.37 = 908$ pounds pressure per square inch, which is equal to the limit that Mr. Scott fixes. This is allowing that the half box had a bearing on one-half of the circumference, which was not the case, as it was considerably short of it.

After a time this 16-inch cylinder was taken off, and a 20-inch put on instead, while the crank pin was not disturbed. The area of a 20-inch circle being 314 square inches, the total pressure rises to 26,062 pounds, or 1,418 pounds per square inch, and the bearing does not heat. Now, if there is a limit to the pressure that oil will stand, which is fixed at about 900 pounds per square inch, it appears as if there would

be but little of it left when this is exceeded by more than 50 per cent. I give this data just as I find it, which seems to show that something is wrong somewhere, for the crank pin gives the engineer no trouble. It is true that the force acting on the pin does not always act in one direction as in the case of some other bearings, but it should be remembered that while the direction of force is changed, the pin has turned over, thus presenting the same side of it to the heaviest pressure. W. H. WAKEMAN.

The Angle of Projection.

Editor American Machinist:

In the drawing room of the Gates shops, Chicago, we invariably use the third-angle method of projection in the arrangement of the drawings, and I am convinced that no other method can compare with it for clearness and legibility. I do not say that the first-angle method is not clear, and that it cannot be read, for this would hardly be true, but it certainly is an arbitrary method, and not a natural one, as compared with the third angle. Of course, there are many who will take issue with me on this point, but what of that? It is the fate of all who say anything in favor of either side of any question in controversy.

I have said that I consider the third-angle method the more legible of the two. My reason is that the individual who is to read a drawing made by the first-angle method of projection *must* bring into use *some* imagination. The use of the imagination as a means of reading so important and expensive an affair as the simplest detailed drawing is, certainly must be very bad policy, to say the least. I hold that a drawing should be so clear, so exact, so complete, that its meaning is beyond question, and no effort of the imagination is required of the one who attempts to read it.

One is obliged when reading a first-angle drawing, to associate in his imagination the view found to the right of the front view with the form of the left end or side, the view found on the left of the front view with the form of the right end; the view at the top with the bottom. Why? Only because of the unnatural and arbitrary arrangement of the views, for which there is no practical reason. I do not deny that one can become accustomed to this arrangement, but why should any person do so?

By examining a drawing made by the third-angle method you find the very location of the views significant of what face or side of the object they represent; in fact, they bear the same relation to each other that the various surfaces of the object they represent do to each other. This is natural, not artificial. Did it never occur to you that this is the arrangement that more nearly conforms to the association or arrangement of the sides or faces of all objects? Who, of all the advocates of the first-angle method, has ever seen such an object that, as he faced the front side, he found that the end located on the right was the left end, and that the end upon the left was the right end, and the surface located on the bottom of the object was its top?

I was taught the first-angle method, but it was always "a thorn in the flesh" to me, and when left to my own inclinations I have invariably used the other in an experience of 12 or 14 years, either in practical work on the board personally, or in directing the work of others, and I have yet to find an object that cannot be more clearly delineated by the third than by the first-angle method.

I have never held the opinion that a draftsman's equipment of instruments should include a crowbar, a crane, or jackscrews, to turn over anvils, invert locomotives or buildings, etc., so that the various sides may assume the positions required to illustrate the first or any other angle method. Is it not ridiculous to consider the revolution or inversion of any object that has as yet no definite shape, even in the mind of the designer? Or, for that matter, why talk of inverting or revolving any object in order to delineate its various sides? What has the revolution of an object to do with its delineation anyway? None whatever.

The mere fact that by the third-angle method the views naturally assume more nearly the same relation to each other that the sides or faces of the objects represented do, was, and still is sufficient reason for me to continue to practice it on all drawings whose construction is left to my charge.

Would I not be consistent if I were an advocate of the first-angle method, if I required the draftsman, Mr. A., who is located at one end of our 80-foot drawing room, to keep his instruments in the drawer of Mr. B.'s drawing stand, at the other end of the room, and Mr. B. to keep his instruments in Mr. A.'s stand, and rely on the first-angle method to properly project them to their respective owners, or make them appear there upon the proper planes of projection?

That the first-angle method has been in use for so many centuries in Europe, and that the Europeans have accomplished so much during that time by it, only shows how conservative and persistent a race they are and nothing more.

I believe the third-angle method to be most universally used here, in America, judging from the drawings that I have seen from other institutions, and also from the American draftsmen with whom I have come in contact. We file all blue prints received from other concerns, and probably have on hand several thousands; among these are very few of the first-angle method, and, judging from the "round writing" on these few, I am almost certain they were made by European draftsmen, or draftsmen who have been taught the European methods.

You will notice that I have not taken up the solving of mathematical problems by either method, which is hardly necessary. Others have said enough upon this subject, and it hardly enters into the question in a drawing room where the drawings are made for practical use. However, any problem that can be solved by the first can be readily solved by the third-angle method.

In regard to those who advocate the use of both angles of projection upon one drawing I have little to say, as the reason for such a practice is entirely beyond my comprehension. A drawing so made must lead to confusion in the shop and cause innumerable errors. Of course, I can understand that where the chief draftsman has time to follow each drawing through the shop and talk with every workman regarding every drawing, this method might be used, but even then there is no excuse for it, and I do not believe that any first-class institution would tolerate such drawing. To my mind drawings should be an absolute record of all that pertains to the subject, and they should be as nearly uniform as is possible.

To secure uniformity, I furnish each draftsman, upon his commencing work in this institution, with what is called an "instruction sheet," upon which he will find such information as he may require regarding all points that may come up regarding the making of drawings. Please find inclosed a copy of the above instruction sheet, which may be of some interest to you.

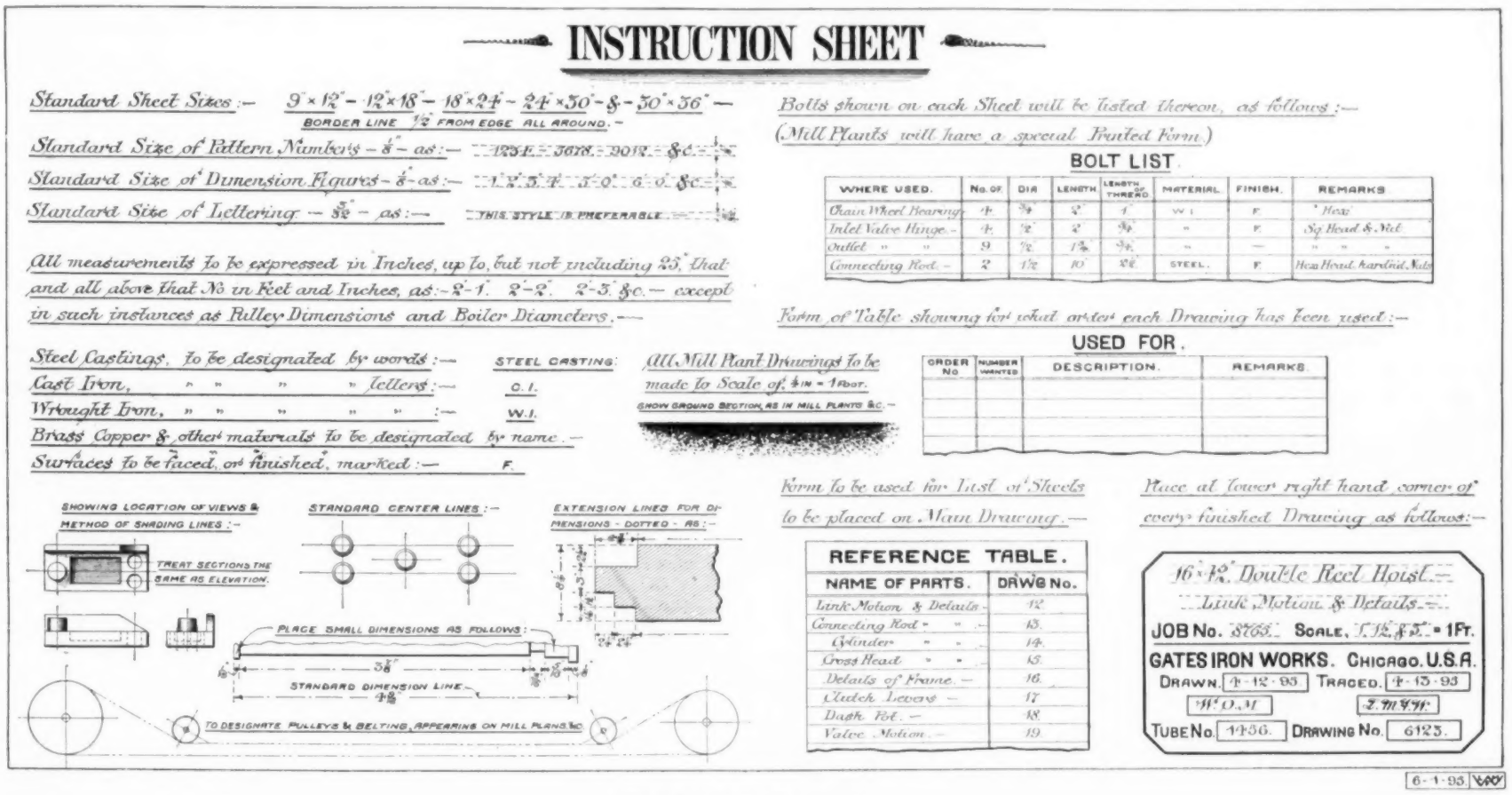
Chicago, Ill. C. L. CARMAN,
Chief Draftsman Gates Iron Works.

[We are happy to make the AMERICAN MACHINIST the instrument of communication between Mr. Carman and the mechanical fraternity at large, and to also put the very clear and comprehensive instruction sheet mentioned by him in print herewith. Only those familiar with shop constructions can understand the vast importance of absolute uniformity of all drawing details, such as are specified and defined in this reproduction; this uniformity of lettering, figuring and list-making should certainly be so nearly absolute that the information conveyed shall be the only thing impressing the mind to be guided by it; the form in which that information is conveyed should be so familiar that the mind takes no note of it whatever; this can be the case only where perfect uniformity of detail in drawings is the rule.—ED.]

The Largest Drop Hammer.

Editor American Machinist:

We see in your issue of the 5th inst. a statement that a 1,200-pound drop hammer was the largest ever made in this country, if not in the world. We have made several larger than 1,200 pounds and are now making for The Pope Mfg. Co., of this city, a drop hammer, the hammer head of which weighs 2,000 pounds, and the base 30,000 pounds (15 times as much as the hammer head), the total weight of the machine being 50,000 pounds. We have just delivered to the same company one, the hammer of which weighed 1,200 pounds and the base 18,000 pounds. The 2,000-pound hammer is now under construction at our works, and we shall be pleased to show the same to our friends if they will call on us. Both of these hammers will be finished and running about November 1st at The Pope Mfg. Co.'s works in this city. We think we can safely say that the 2,000-pound hammer is the largest yet made. PRATT & WHITNEY CO.,
Hartford, Conn. F. A. PRATT, Pres.


INSTRUCTION SHEET
Standard Sheet Sizes:— 9"×12" - 12"×18" - 18"×24" - 24"×36" - & - 30"×36" —
BORDER LINE ½" FROM EDGE ALL AROUND.
Standard Size of Pattern Numbers - ⅛" - as:— 1234. 3678. 2013. &c. ⅛"
Standard Size of Dimension Figures - ⅛" - as:— 1'-2½". 5'-7". 3'-0". 6'-0". &c. ⅛"
Standard Size of Lettering — 3/32" - as:— THIS STYLE IS PREFERABLE ⅛"
All measurements to be expressed in Inches, up to, but not including 25", that and all above that No in Feet and Inches, as:- 2'-1". 2'-2". 2'-3". &c.— except in such instances as Pulley Dimensions and Boiler Diameters.—
Steel Castings, to be designated by words:— STEEL CASTING
Cast Iron, " " " " letters:— C.I.
Wrought Iron, " " " " " :— W.I.
Brass Copper & other materials to be designated by name.—
Surfaces to be faced, or finished, marked:— F.
SHOWING LOCATION OF VIEWS & METHOD OF SHADING LINES:—
TREAT SECTIONS THE SAME AS ELEVATION.
STANDARD CENTER LINES:—
EXTENSION LINES FOR DIMENSIONS - DOTTED - AS:—
PLACE SMALL DIMENSIONS AS FOLLOWS:
3⅝"
STANDARD DIMENSION LINE.
4⅝"
TO DESIGNATE PULLEYS & BELTING, APPEARING ON MILL PLANS &c.
Bolts shown on each Sheet will be listed thereon, as follows:—
(Mill Plants will have a special Printed Form.)
BOLT LIST.
WHERE USED. | No. OF. | DIA. | LENGTH | LENGTH OF THREAD | MATERIAL | FINISH. | REMARKS
Gear Wheel Bearings | 4 | ¾ | 2" | 1" | W.I. | F. | Hexa
Inlet Valve Hinge - | 4 | ½ | 2" | ¾" | " | F. | Sq Head & Nut
Outlet " " | 9 | ½ | 1¾ | ¾" | " | — | " " "
Connecting Rod - | 2 | 1½ | 10" | 2½" | STEEL | F. | Hexa Head, hardened, Nuts
Form of Table showing for what order each Drawing has been used:—
USED FOR.
ORDER No. | NUMBER WANTED | DESCRIPTION. | REMARKS
All Mill Plant Drawings to be made to Scale of ½ IN = 1 FOOT.
SHOW GROUND SECTION, AS IN MILL PLANTS &c.—
Form to be used for List of Sheets to be placed on Main Drawing.—
REFERENCE TABLE.
NAME OF PARTS. | DRWG No.
Link Motion & Details - 12
Connecting Rod " " - 13.
Cylinder " " - 14.
Cross Head " " - 15.
Details of Frame. — 16.
Clutch Levers — 17
Dash Pot. — 18
Valve Motion. — 19
Place at lower right hand corner of every finished Drawing as follows:—
16"×42" Double Reel Hoist.—
Link Motion & Details.—
JOB No. 8765. SCALE, 1½"=1FT.
GATES IRON WORKS. CHICAGO. U.S.A.
DRAWN. 4-12-95 TRACED. 4-13-95
W.D.M. F.M.W.
TUBE No. 1456. DRAWING No. 6123.
6-1-95

THE ANGLE OF PROJECTION.

A few weeks ago a man, rendered desperate by hunger, broke into a north side bakery and stole two loaves of bread for which he was promptly arrested and sent to the bridewell. Last week, it was ascertained that certain wealthy packers at the stock yards had long been stealing the city water. The amount of the thefts, while it can never be definitely ascertained, is simply enormous, the present estimates placing the aggregate at over 40,000,000 gallons per day. The Union Stock Yards and Transit Company, a corporation of immense wealth, has been doing the same thing. These enterprising companies apologize for the theft and state that the fact was unknown to any of their officials or managers. Certain wicked workmen, anxious to aid in the good work of swelling the already fat dividends of the various companies, made the connections, stole the water and, very discreetly, said nothing about it. Of course it is not expected that anyone will believe these fairy stories. We ought to be consistent, however. Either release the poor man who stole the bread, or send these wealthy thieves to help him break stone.—*Chicago Journal of Commerce.*

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FRED J. MILLER, Editor.

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☞ *We publish nothing in our reading columns for pay, or in consideration of advertising patronage. Space in the advertising pages only is for sale.*

☞ *We invite correspondence from practical machinists, engineers, inventors, draftsmen, and all those specially interested in the occupations we represent on subjects pertaining to machinery.*

☞ *Every correspondent, in order to secure attention, must give his full name and address; not necessarily for publication, but as a guarantee of good faith.*

☞ *All communications for, or relating to the reading columns should be addressed to the editor. All other communications to the company, as above.*

☞ *Subscribers can have their mailing address changed as often as they desire. Send both old and new addresses. Those who fail to receive their papers promptly will please notify us at once. Date on wrapper denotes week with which subscription expires.*

☞ *The* ***American Machinist*** *is not interested in any particular patents, products or factories, to the prejudice of others, but is devoted to the interests of all those who have to do with designing, building, selling and using machinery.*

☞ *Back volumes of the* ***American Machinist*** *for any of the fourteen years, 1880 to 1894, inclusive, may still be obtained. Price unbound, $3.00 per volume postpaid; bound in cloth, $4.00 per volume.*

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Low Cost Manufacturing.

Perhaps some of those who read, in last week's AMERICAN MACHINIST, our article entitled "A Foundry Sketch—Low-Priced Work," may have thought that we had reversed our position with regard to the economy of good shop equipment, and keeping things clean and in good order. We need hardly say that we have not, nor do we intend to become the champion of mere cheapness and dirt as factors in economical shop production, but many of our readers have never been in any but the better class of shops, and know nothing of how work is produced in places where the crudest possible equipment, supplemented by brute force, are thought to be sufficient, and even necessary for the lowest possible cost of production, and it must be interesting to them to get this glimpse of "how the other half lives," and to know what men think whose experience is entirely in other lines.

It has been conclusively demonstrated time over and again that the lowest cost machinery is produced in shops where money is freely but at the same time judiciously spent for equipment and in keeping that equipment clean and in the best possible condition.

Wagon skeins are much more simple, but we are by no means convinced that even here a properly designed and adapted molding machine would not reduce the cost of these castings sufficiently to pay for itself in a short time; and it is quite certain that such a foundry equipment as is in the Westinghouse air-brake shops, the most elaborate and expensive in the country, would pay handsomely on such work if there were enough of it to do.

As to the finishing operations, we firmly believe that well-designed special machines, operated under skilled supervision, in a good light and under good conditions generally would prove economical.

It is undoubtedly true that too much money has been spent in some cases for tools and machinery to be used in manufacturing operations, but this has been done in the West as well as in the East and, independent of geographical considerations, it is a part of the successful mechanic's business to know just how far to go and just where to stop in the matter of expenditures; the class of work to be made, the probable or actual demand for it, the class of help available, and the capital at command, all being considered. We personally know of shops in what is called the West where money has been wasted in (under the circumstances) useless refinements, and, on the other hand, plenty of shops can be found in New England where it would pay handsomely to adopt what would be called far more elaborate and more expensive methods than are now in vogue in them.

Good judgment and skill are by no means confined to any particular locality, but are valuable anywhere, and it is useless to attempt to lay down any particular methods adapted to all lines of manufacture.

It would be highly interesting to visit a factory making small arms, sewing machines, typewriters or bicycles on the plan outlined in the article referred to. The product of such a factory would be a curiosity as would also be the bank account necessary to keep it in operation. We should not expect to find the same equipment and methods in a gun shop as in a plow works, but we are confident that order, system, cleanliness and light pay in any line of manufacturing, and that skill and brains count for more than brute force in this age of *finesse*.

Exact Heating of Steel.

In another part of this issue we publish a communication from Mr. A. A. Simonds, on the above subject, which, we think, should be carefully considered by all who have to do with working tool steel.

Steel makers have long contended that not enough care is exercised in heating tool steel, and that the higher and better grades of steel, particularly, are, in far too many cases, badly overheated.

While the more intelligent of those who work steel know that it can easily be overheated, there is, we think, little idea of how small a variation in heat will make the difference between hardened steel in its best possible condition, and steel about ruined, so far as any purpose requiring strength or a durable cutting edge, is concerned. It is also little understood how easy it is for a smith working under varying conditions both within himself and as regards amount of sunlight, etc., to vary in his heating much more than is consistent with uniformly good results.

The various fractures of a ¼-inch by 1-inch bar heated by Mr. Simonds and quenched at temperatures varying from each other by only 20° F., together with the figures of their transverse breaking strength, show how easily good steel may be robbed of its most valuable qualities by careless heating, while the figures showing the transverse breaking strength of similar bars hardened in fourteen different manufacturing establishments speak eloquently of the difficulties that steel makers have to contend against and show just why it is that a steel known to be excellent—one that has given the best of satisfaction in numerous shops, will be condemned as worthless in other shops, even where the real test of service is not nearly so severe.

After making all possible allowances it is evident from these figures that the same steel worked in different shops under ordinary conditions may be expected to vary greatly in strength and cutting qualities, and it is shown that the establishments which might be supposed to be best prepared to do uniformly good hardening are sometimes as far astray as those in which exact methods and results would not be looked for or expected.

Even in the best shops where such matters are handled with the best equipment and with the most skill there is still a large element of guesswork, and the result will depend too much upon how near to the exact right heat the guess has been. Any practical method of eliminating this guesswork and substituting for it exact measurements of heat ought to be beneficial to all who either make or use tool steel.

The Brake on the Trolley Car.

Of course we cannot follow *Electricity* through all its labyrinthian windings upon the brake question. It certainly makes out a very bad case about the braking of the trolley car without any of our help. It is to be hoped that it does not misrepresent the car as it misrepresents us when it says, "Suppose we add an emergency brake or two, as the AMERICAN MACHINIST would have us do." We have never advocated or suggested an emergency brake for a trolley car, or any brake but one simple, quick-acting brake that should at all times be able to stop the trolley car as quickly as any other car can be stopped. We have the word of *Electricity* for it that we are not likely to see such a brake, and the only way out of it that our contemporary has to suggest is in the discovery of a Briarean motorman.

We have no co-worker more esteemed than our neighbor, the *Electrical Engineer*. It is doing excellent work in every department of its special field, and we are learning from its columns continually. It has presented the facts in connection with electric traction very fully and fairly. It has been specially faithful and constant in its efforts for the safety of electric traction. It has several times spoken of the fenders and brakes in use. In regard to the fenders we are practically in accord. The best that may be said of the best fender is that it may sometime save. We think that the safety of the public is best promoted by the entire absence of the fender, and by keeping the front platform and all the under part of the car in front of the wheels as free and clear as possible. Of course, there must be a quick and efficient brake, and in this connection our attention has been called to the various remarks of our esteemed contemporary concerning the brake on the trolley car, and we venture here to reproduce them. In its issue of March 20th, it said:

It is a better principle to avoid knocking a foot passenger down than to chance picking him up alive, but in a more or less bruised and mutilated condition. . . . To us it seems to be altogether the better way to give the cars improved braking facilities. . . . The main, vital, essential thing to-day is to give the drivers swift, direct, easy control of the speed of their vehicles, and this is to be done only with brakes that act instantaneously.

In the month of May of this year, a young man riding a bicycle was thrown from his wheel immediately in front of a cable car of the 125th street line in this city. "He fell in the middle of the track, but the gripman saw him in time to bring his car to a standstill *a foot away from the young man's head*." The *Electrical Engineer* commented upon this incident as follows, in its issue of May 29th:

Now, it is well known that these cars are equipped with the Genett air-brake—and not the later, better form of it, either. If Brooklyn will only insist on its trolley cars having such a brake, its modern citizens can have cars just as fast as they need them, and its 200,000 sleepy, antiquated citizens who have hitherto objected, can still stay on the track as long as they like, with impunity. The air-brake on all street car lines is as inevitable as it has proved to be on steam railroads, and we have no doubt that within a very few years every car in every city will have it.

Speaking of the numerous victims of the trolley in Brooklyn, our contemporary says, June 5th:

A large number of them were, alas, victims of their own stupidity and folly, and many of the others would have escaped were the cars provided with decent brakes or fenders.

July 10th, it said:

As we have said before and now repeat, good brakes are more necessary to the cars than poor fenders; and we hope ere long to see public opinion intelligently directed to that part of the subject.

That is all. Can any one who understands the situation claim that in the above is *the whole truth* about the brake on the trolley car? Certainly swift-running cars should have quick-acting brakes. It is not telling us much to tell us that. But is it true or is it untrue, is it acknowledged or is it denied that, as we asserted, "an electrically-driven car upon a street railway, a trolley car, either an overhead trolley or an underground trolley, and especially, and for an additional reason, a car operated by a storage battery, cannot, either of them, *with safety to itself*, be stopped as quickly as any other car of the same capacity and running at the same speed?" Is it true or is it not true that electric cars are purposely equipped with slow-acting brakes, and that human lives are being sacrificed for the safety of the motor mechanism?

The International Yacht Race.

The America's cup was a happy thought. Its establishment has stimulated a national rivalry of the healthiest sort. Of all the participants in the several contests that have occurred for its possession none on either side have anything to be ashamed of, and apart from the pangs of defeat, none have anything to regret. Mutual respect has been promoted, and friendly feelings have been fostered. Of the directly practical value of the yacht races, it is not easy to say wherein they consist. The yachts are worthless for any actual use of man, and the success of either side demonstrates nothing. In the combination of conditions by which success is secured, the correct relative value of each can never be determined. When a race is won no one may say whether it was in the model of the boat, or in the set of the sails, or in the fickle wind, or in the toss of the waves, or in the steering, or in the happy thought and the quick, correct act at the critical moment. The performance cannot go on record for future comparisons, for never again can the precise conditions occur. Still, both to the active participants and to the spectators, a yacht race cannot fail to possess the keenest in-

terest. The engineer worthy of the name could by no possibility look on without a stimulating or a suggestive thought. It is, after all, not altogether right to say that yacht racing has no immediate practical value. The skill involved in the modeling, the equipping, and the sailing of these craft is skill available, and finding employment in other fields of highest usefulness. If yachting can give the merchant marine of the world some points on skin resistance alone, and we believe that it already has, that is worth more than all the money that has, as some may think, been foolishly spent. We trust that we may continue to see these occasional international contests, and every time may the best combination of boat and men secure the possession of the cup.

A Transparent Fraud.

In our issue of August 1st, under the head of "Wanted," a two line advertisement appeared signed "Espanol," and stating that an engineer was wanted for a Spanish country. It is our belief that the advertiser is a fraud, though we have reason to believe that he did not succeed in entrapping any reader of our paper. His game was too transparent to succeed among intelligent men. We have two letters written by him in reply to answers to his advertisement, in which he agrees to employ the writers of the answers, and asks them to send him $25 to bind the contract. Instead of sending the money, his letters were promptly sent to us and we immediately took steps to secure for him such treatment as he evidently deserves. A skillful detective has, however, so far failed to find trace of him, and no such person as James L. Boice is known or can be found at the addresses he gave in his letters, and to which he evidently hoped our readers would send him money, entirely without security or assurance. We usually endeavor to know that advertisements accepted by us are genuine, but in this case were deceived. We think, however, that swindlers will generally waste their time when trying to work amongst machine constructors and engineers.

A Serious Loss by Fire.

On the 24th of August, the shops of Webber & Philbrick, near Waterville, Me., were destroyed by fire, and in an extension of their building was the mechanical laboratory and workshop of Prof. Wm. A. Rogers, which was also destroyed, involving the total loss of his large screw-cutting engine, his machine for testing screws, machine for grinding screws, and a reversible, sectional nut used for correcting errors, depending upon a single revolution of the screw, which last Professor Rogers informs us he valued more highly than any other of his possessions. He lost also other machine and small tools, and carried no insurance.

Professor Rogers now declares that he has spent enough money on such things, and will not rebuild; so that this fire becomes a loss to science and to the world.

Questions and Answers.

Questions of general interest relating to subjects discussed in our columns will receive attention in this department. The writer's name and address should always accompany the question. Neither correct initials nor location will be published when there is a request to that effect. If questions are enclosed with a business communication, they should be written on a separate sheet. We cannot undertake to answer questions in "next issue." This department is usually crowded, and questions must wait their turn to be answered. Neither can we undertake to solve mechanical or engineering problems, and send answers by mail.

(344) A. H. N., Scranton, Pa., writes: Kindly inform me of a good book treating on galvanizing wrought-iron. *A.*—We do not know of any book which treats on this subject exclusively. In the "Metal Workers' Handy Book of Receipts and Processes," by W. T. Brannt, you will probably find as good and as complete a description of the process as in any other book.

(345) B. U. C., Lockport, N. Y., writes: I have a pair of boat engines on one base, cranks set at right angles to each other; cylinders, 3¼x3¼ inches. I wish to use a compound engine in place of these, and use a 4x4 high-pressure cylinder; what should be the diameter of the low-pressure cylinder, and what will I gain in power, running with 120 pounds steam pressure, and at a rate of 275 revolutions per minute? *A.*—The low-pressure cylinder should be 8 inches diameter. This engine, non-condensing, should develop about 5½ horse-power. We do not know the conditions under which the simple engine was run, and therefore cannot give the gain in power; this, however, will be small, if any. The gain will be in fuel.

(346) M. J. F., Brooklyn, N. Y., writes: I want to make a cylindrical float or buoy with conical ends 2 feet long; length of buoy over all, 8 feet. It is to be made of steel as light as possible and stand any kind of climate without getting injured, and support a load of 700 pounds, what should be the diameter of the cylinder? *A.*—We should make the cylinder 3 feet diameter, of steel $\frac{3}{16}$ inch thick. 2. Should the buoy be filled with compressed air or oxygen, and what quantity will be required? *A.*—If it has to be filled at all we should use air; we do not know how much air should be compressed without knowing the purpose for which the buoy is to be used. 3. What will it cost to fill the buoy? *A.*—You must get your own estimates as we are not concerned with the cost of machinery, we are simply interested with the construction, use and efficiency of machines. 4. Please give rule for computing the horse-power of an engine. *A.*—See answer to Question 496, in our issue of October 25, 1894.

(347) H. A. S., Aylmer, Canada, writes: Kindly explain the cause of our difficulty we have with our syphon of the following dimensions and distance. We have been trying to syphon water from one well to another 350 feet apart; the water in one well is 10 feet higher than in the other. We first laid a 1-inch pipe all the way, but as it would run only from one to two hours at a time after starting, we took the upper half out and replaced it by a 1¼-inch pipe, and before starting tested it with a force pump to discover leakage, if any, but found none. We have been using it for a month, and our difficulty is that, as soon as the water in the wells approach a level with each other, the syphon stops, and will not start again during the time the water is used out of one well, until the pipe is opened and refilled. Please give us a reason for this. *A.*—The reason for the stopping of the syphon when the water approaches the same level in both wells is that there is not a sufficient head in one of the wells to overcome the friction of the water in the pipe. Also, when the velocity of the water in the pipe is low, air is liable to collect in the pipe and stop the flow of water. It must not be expected that after a syphon has ceased to work that it will start by simply lowering the water level in one well; the syphon must be refilled before it can start.

(348) A. A. E., Paterson, N. J., writes: Please give me a formula for computing the amount of power that there is in cut gears. For example: What pressure can be resisted by a cut gear 22 inches diameter, 1½ inches wide, No. 8 pitch. Or take another example: One gear 48 inches diameter, 4½ inches wide, and No. 4 pitch. *A.*—There are in existence about fifty well established rules for horse-power and working strength of gear teeth, sanctioned by some twenty-six authorities, and differing from each other in extreme cases about 500 per cent. The following rule will probably give a good general average. Multiply 2,000 by the circular pitch in inches, and by the width of face in inches, the result will be the breaking load in pounds of a cast-iron tooth. For a safe working strength not more than one-sixth of the breaking load should be taken. Applying this rule to your first example, we first find the circular pitch by dividing 3.1416 by 8 (the diametral pitch) which gives us .3927 for the circular pitch. Now by the foregoing rule the breaking load of the tooth will be $2{,}000 \times .3927 \times 1.5 = 1{,}178.1$ pounds; and the safe working load will be $1{,}178.1 \div 6 = 196.3$ pounds. In the second example, the circular pitch will be $3.1416 \div 4 = .7854$, and the safe working strength will be,

$$\frac{2{,}000 \times .7854 \times 4.5}{6} = 1{,}176.1 \text{ pounds.}$$

(349) H. A. C., Hamilton, Ohio, writes: Kindly answer the following: A wire rope 1¼ inches diameter, weighing 2.35 pounds per foot, is suspended from two supports 400 feet apart, and the above rope has a deflection of, say, 20 feet, what stress will there be on each support? Again, suppose the above rope has suspended from its center a load of two tons, what stress will then be on each support? Kindly give me an approximate rule for working out such problems. *A.*—If the supports are at equal hights from a horizontal line, then the tension on the rope at either one of the supports is found by the following rule: Find the square of one-half the span, add this to the square of twice the deflection, find the square root of this sum, and divide the result by twice the deflection; lastly, multiply this quotient by one-half the entire weight of the clear span and its load; the result will be the tension on rope at either one of the supports. In symbols we have,

$$T = \frac{\sqrt{(\frac{1}{2}S)^2 + (2D)^2}}{2D} \times \frac{1}{2}W,$$

in which T = tension on rope at either support, S = span, D = deflection, and W = total weight. This rule is applicable to both problems by simply inserting the proper value for W. In the first case W is equal to the total weight of the rope; in the second case it is equal to the weight of the rope plus the suspended weight.

(350) F. N. B., Boston, Mass., writes: In your issue of August 1st, in answer to Question 294, you give a formula for estimating the power of a coiled spiral spring. I am interested in spring motors, so I write for further particulars. Do you mean by the term "stress" (S) the elastic tension per square inch of the metal? *A.*—By "stress" is meant the internal forces, or resisting forces in a body called into play by the action of a load or the application of external forces. In the formula referred to, S = stress per square inch, well within the elastic limit. 2. If the elastic tension of the metal is 48,000 pounds per square inch, and the spring is made of steel 1 inch wide and ⅛ inch thick, will 6,000 be the stress in that spring? *A.*—The stress in the metal will depend on the load or force applied, and when the load is known can be found by the following formula, which has been deduced from the formula above referred to:

$$S = \frac{6 \times R \times P}{b \times h^2}, \qquad (1)$$

in which S = stress in pounds per square inch within the elastic limit, P = force or load in pounds applied, b = width of blade in inches, h = thickness of blade, and R = distance in inches from the center of the spring to the point of application of the force or load. 3. Does R mean the distance from the center of the arbor to the rim of the barrel? *A.*—Yes. 4. How can one estimate before hand the number of turns a spring will make on unwinding? *A.*—We should determine this data by experiment on a number of different springs, and keep the data thus obtained for future use. 5. How is the spring motor in a music box controlled so as to prevent it unwinding all at once? *A.*—By a governor. 6. Is the following computation correct? Let $b = 1$ inch = width of blade, h = its thickness = ⅛ inch, R = radius to the point of application of force, $P = 5$ inches, and $S = 24{,}000$ pounds per square inch of metal.

$$P = \frac{24{,}000}{6} \times \frac{1 \times \frac{1}{64}}{5} = 12\frac{1}{2} \text{ pounds.}$$

A.—Yes.

Business Specials

Transient Advertisements 50 cents a line for each insertion under this head. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue.

Gear Wheels, Gear Cutting. Grant; see page 752.

Forming Lathes, Mer. Mach. Tool Co., Meriden, Ct.

Milling Machs. Kempsmith Co., Milwaukee, Wis.

Marine Iron Works, Chicago (new catalog).

Patent Solicitor. J. G. D. Mack, Madison, Wis

Selden Packing for stuffing box, with or without rubber core. Randolph Brandt, 38 Cortlandt St., N.Y.

A book for superintendents, "Hawkins' Calculations" (descriptive), $2.50 postpaid. Catalog free. Theo. Audel & Co., 91 Liberty street, N. Y.

Squaring and Rotary Shears, Tinsmiths' Tools, Presses and Dies for sheet metal work, are made by the Niagara Stamping and Tool Co., Buffalo, N.Y.

Improved Duplex and Special Gear Cutters in stock and to order; Gear and Milling Cutters of all descriptions. R. M. Clough, Tolland, Conn.

I keep in stock brass pattern letters and numbers, with spurs on the back to hold them on. They never drop off. Same price as lead letters. Write for sample, free. Twining Campbell, Brass and Aluminum Founder, Paterson, N. J.

A responsible concern, with shops in New England, well equipped with modern tools and force of the best mechanics obtainable, temporarily quiet on their own work, will undertake to design and build for manufacturers, special light machinery, tools, fixtures, etc., requiring the highest degree of accuracy. Address L. T. D., AM. MACHINIST.

Abstract of Report of Committee on Standard Tests and Methods of Testing Materials.*

By Gus. C. Henning.

CAST-IRON.

The work of this committee has been so far advanced that it was possible to make a comparison of transverse breaking loads of all tests of square bars. It must be pointed out that these comparisons are based upon the *actual breaking loads* of the *bars as cast* and not upon the calculated maximum outer fiber strains, taking into account actual dimensions of bars.

As Mr. W. J. Keep, of Detroit, member of the committee, first received the results of tests, having provided the bars, it fell to his part to write the paper on the results.

At the December meeting of the society this committee discussed the behavior of cast-iron in the mold, as to whether it expands or shrinks while cooling, and it was thought advisable that the subject be carefully studied. As Mr. Keep had the necessary facilities he built the autographic recorder shown by Fig. 1 by which the results and curves given in his paper on "Cooling Curves" were obtained. In the paper on "Transverse Strength" the results of tests of bars, obtained as described in the paper No. DCLVIII. "Description of Tests," are given.

The principal facts developed are these: That the transverse strength of cast-iron depends mainly upon the size of the casting and upon the amount of silicon (Si) in the iron.

All other conditions have influence more or less pronounced, but are subordinate to these. The fact became apparent that, while the highest silicon iron produced the strongest small bars less than 1 inch thick, it made the weakest large bars 2 inches thick and over. It also became apparent that irons of any and all compositions gave results nearly alike when castings about 1 inch square or thick were produced, and that very little information could be obtained from test bars 1 inch square or thick, while either thinner or thicker castings would show the variations in qualities in a much more marked and decided degree. The very thin castings, however, gave precisely the reverse results of those obtained by thick shapes.

The *phosphorus* remained constant in all sizes of bars, each series of tests, however, varying from the other in the amount contained.

The *sulphur* also remained identical for all sizes of castings in each series, the amount contained in different series varying.

The *silicon*, however, varied nearly 400 per cent. in large and small castings, the general fact being that large castings contained more silicon than smaller ones, all being poured from the same ladle as nearly as possible. Why this variation should occur is not yet understood, but may be found to be the cause of so many vagaries met with in cast-iron. It was quite certain that the correct amount of silicon was put into the cupola to begin with, but there never was any certainty what the iron coming out of it would contain. This silicon table clearly shows these differences:

SILICON CONTENTS BY ANALYSES.

Series.	Nominal Silicon.	Iroquois Mixtures. ½" sq.	1" sq.	1"x 2".	2" sq.	3" sq.	4" sq.	Sl. Av.
	p. c.							
1	1.00	.83	.79	.78	.82	.72	.88	.81
2	1.50	1.09	1.14	1.70	1.33	1.10	.88	1.20
3	2.00	1.73	1.73	1.70	1.50	2.17	2.50	1.88
4	2.50	2.13	1.69	1.60	1.80	2.17	2.07	2.01
5	3.00	2.42	2.65	2.40	3.36	3.67	4.67	3.19
6	3.50	2.74	2.69	2.70	2.62	4.30	3.22	3.04

*"Transverse Strength of Cast-Iron," "Keep's Cooling Curves—A Study of Molecular Changes in Metals Due to Varying Temperatures." By W. J Keep, Detroit, Mich., Member of the Committee o Standard Methods of Tests, A. S. M. E.

HINKLE MIXTURES.

7	1.00	.91	.93	.86	.90	.85	1.12	.93
8	1.50	1.16	1.29	1.10	1.22	1.25	1.08	1.17
9	2.00	.93	1.40	1.05	1.00	2.15	3.50	1.67
10	2.50	2.84	2.55	2.70	2.00	1.75	1.57	2.23
11	3.00	2.56	2.75	2.97	2.49	2.64	2.84	2.71
12	3.50	2.77	3.75	3.41	2.91	2.89	2.95	3.05

SOUTHERN.

14	....	2.70	2.80	2.81	2.79	2.94	2.81	2.81
13	....	3.13	3.22	3.17	3.19	3.20	3.15	3.18
15	....	3.29	3.50	3.52	3.48	3.75	3.42	3.51

BRITTING.

16	....	1.86	1.77	1.82	1.77	1.77	1.80	..

The average silicon is always less than that put in, showing that a portion is invariably burnt out or combines to make slag. There is nothing to show which of these two results affects strength, but it must have some influence and may be the cause of the irregularity in them.

Strength increases in the ½-inch square bars with each increase of silicon.—These tests show this to be true, with increases of silicon as high as 3.50 per cent., and this is as high as it will be found in any ordinary foundry mixture. The castings are also softer with each increase of silicon. This also corresponds with foundry experience.

Strength decreases as castings increase in size, when both large and small castings are made from the same iron. Decrease in strength is more rapid in castings between the sizes of ½ inch square and 1 inch square than between larger sizes. The decrease grows less rapid for some differences in silicon as the size increases.

Decrease in strength is greater and more rapid with each increase of silicon.—In each of the charts the curve representing the strength due to the lowest percentage of silicon begins lowest on the ordinate of the ½-inch square test bar, but owing to the decrease of strength due to each increase in size of test bar the curve ends on the ordinate of the 4 inch square bar at a point much lower than that at which it began.

The curve representing the strength due to the highest percentage of silicon begins at the highest point on the ordinate of the ½-inch square bar, and because the increase of silicon causes a more rapid decrease of strength in the larger bars, the curve drops much more rapidly than the low silicon curve. This causes the distance between the curves to diminish as the size of the bars grows larger.

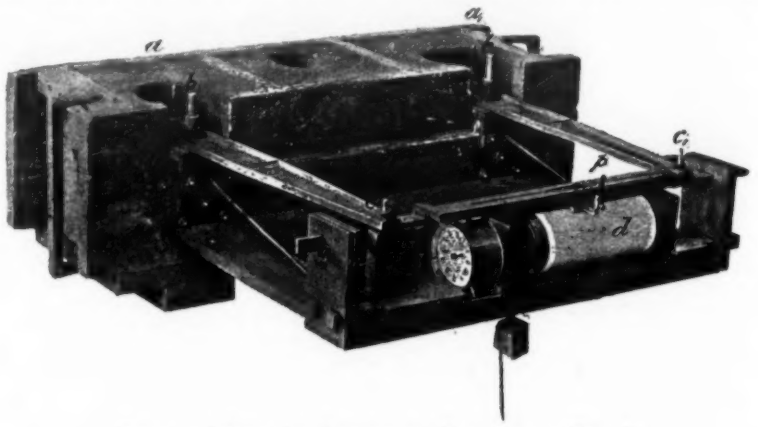
The record of one size of test bar cannot indicate the strength of another size, for the reason that, with the same iron, aside from the local causes of derangement, any change in size, or, in other words, any change in the rate of cooling, will change the grain and strength. Each mixture of iron and each percentage of silicon will produce the best results in some one single size of casting, and not as good a result in any other size.

METHODS FOR PRODUCING THE STRONGEST CASTINGS.

This resolves itself into methods for producing a close grain free from brittleness.

1. *Using a low silicon iron for large castings.*—The lowest silicon iron shows the least strength in the ½-inch square test bar on account of brittleness, but slow cooling opens the grain in the larger castings enough to turn the iron gray and to remove brittleness. In all the charts it is seen that the low silicon irons give the weakest ½ inch square, and the strongest large castings (except series 17 which was not melted in a cupola). For a casting 2 inches square the silicon may vary anywhere between 1 and 1½ per cent., and give the greatest strength. Large castings made from low silicon irons will tend to be hard.

2. *Using higher silicon irons which naturally have a close grain.*—By this method the higher silicon makes the casting soft, and a pig-iron or scrap which has a close grain will retain this closeness in the casting. Southern irons have generally closer grain than Northern iron, and charcoal iron generally has a closer grain than coke iron. Southern foundry forge, or No. 3 foundry, or Nos. 1 and 2 soft, are all close-grained irons, but with enough silicon to make very soft castings.



DRAWING COOLING CURVES OF CAST-IRON.—FIG. 1.

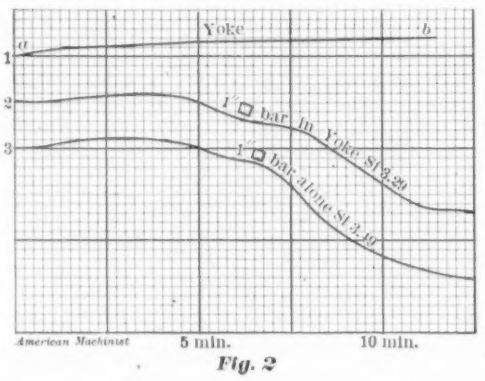


Fig. 2

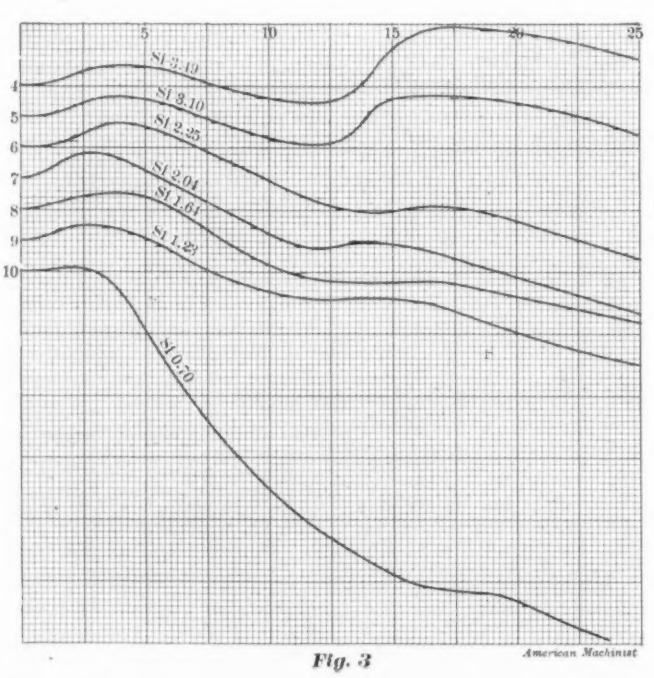
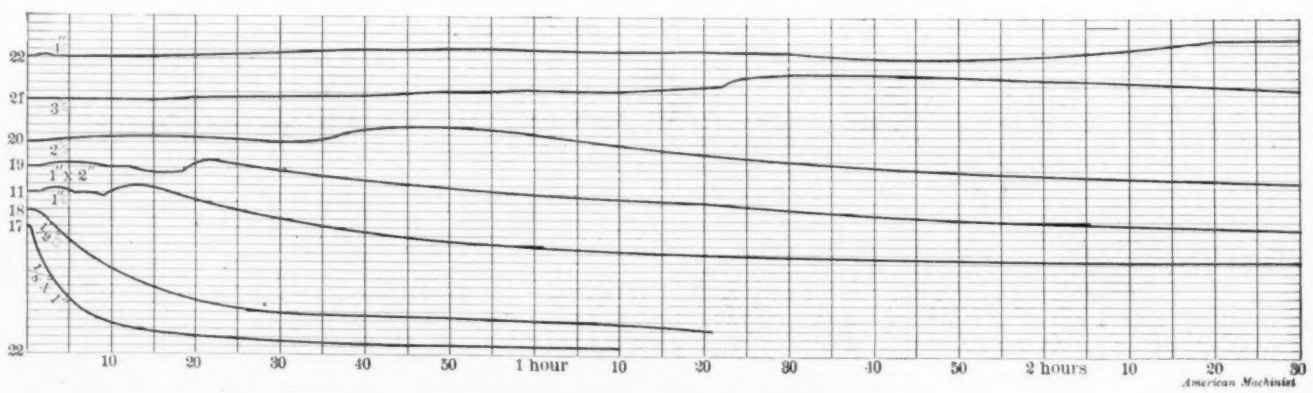


Fig. 3



COOLING CURVES OF CAST-IRON.—FIG. 4.

Series 14, 13 and 15 (see Table of Transverse Breaking Loads) are records of mixtures of all Southern iron of Nos. 2 and 3 foundry, and 1 and 2 soft. These irons are not generally expected to make strong castings, because of the fact that they have silicon higher than is generally found in heavy castings, and because of the opinion that silicon weakens large castings. In this mixture which produced this series the silicon is 3½ per cent., and the strength in the ½-inch square bar is above 400 pounds, which is above the average. Slow cooling does not open the grain as rapidly as it did with the 3½ per cent. "Iroquois" series, and in the 4-inch square bar it gives the same strength as the 1 per cent. "Iroquois." This special mixture makes stronger castings for all intermediate sizes.

In this case we have the stove-plate iron stronger for all sizes, but simply because the grain is kept close. This kind of strength costs nothing. Scrap-iron and close-grained pig-iron cost less than open-grained pig-iron.

The first method of using low silicon pig-iron is in most common use, and the latter method requires the knowledge that a closing of the grain produces strength, and also that a pig-iron with a close grain will make a close-grained casting. If the founder has learned this, he is on the right track. When the principle of keeping the grain uniform and close, and the iron soft, has been learned, pig-iron from almost any furnace can be found with a suitable grain. The mixture that produces the strongest ½-inch square bar with the closest grain will also show greatest strength in a casting 4 inches square, if the grain is kept close.

3. *Powdered ferro-manganese* is often thrown into a ladle to cause a fine granular structure.

4. *Wrought-iron borings or chips* put in the cupola along with the pig-iron will cause the grain to be close, and in this way add strength.

A rod of wrought-iron is sometimes held in the spout of the cupola, so that the end may melt off and mix with the metal. An old file is sometimes melted in a ladle for the same purpose.

5. *Cast-iron chips or turnings* are sometimes placed in wooden boxes with the covers nailed on and charged along with the pig-iron, to cause an even and close granular structure in the casting.

The total carbon was identical for all sizes of castings for each series, while it was practically the same for all series varying between 3.10 and 4.00 per cent., showing that cast-iron absorbs and holds a certain amount of carbon. But the condition of the carbon contained is of great importance, and the table shows the amounts of combined, graphitic, and of average total carbon in each series.

Combined carbon may decrease as castings are larger, but the strength always decreases. This decrease of combined carbon and of strength are both caused by the slow cooling, and the decrease of combined carbon has nothing to do with the decrease of strength.

From an examination of these analyses and the table of strength given on next page, strength or weakness seem to be absolutely independent of *graphitic carbon*.

Manganese was identical in all castings of each series, and as the amount in different series was very nearly the same, no effect of this element *could be traced*.

In a previous paper Mr. Keep discussed the total shrinkage of cast-iron as affected or produced by silicon; but to observe this quality more closely and to determine whether there was any expansion previous to final shrinkage, the apparatus shown by Fig. 1 was built by Mr. Keep, and surprising results were obtained.

The apparatus consists of a flask in which bars are molded, to which flask are attached two multiplying levers of same ratios, the one carrying a pencil while the other slides a revolving paper-covered drum longitudinally.

The metal is poured into the mold and flows around pins *a a*, so that if the ends of the solidified bar move, the levers will swing around pivots *b b*, moving the pencil *p* and drum *d* in a straight line, being hinged at *c* and *c*. The levers are of iron expanding at right angles to their motion, while the frame of machine, being of wood, does not expand longitudinally when affected by the heat of the casting in the flask.

Hence the line drawn by the pencil *p* will give a pretty correct representation of total motion of both ends of the casting in the flask.

Curves like Nos. 2 and 3 in Fig. 2 were obtained, showing that this grade of cast-iron does expand before becoming cold, and about $\frac{1}{5400}$ of its length, or about 0.04 per cent., which is disappearingly small.

However, other irons were tried, the curves of which are given in Fig. 3.

These irons are practically the same as those described in the first part of this paper. It will be noticed that these curves vary with the amount of silicon in the iron, and that the expansion is nothing in that containing .70 per cent. silicon, but rises to about 0.175 per cent. in iron containing 3½ per cent. silicon.

Curves 1, 2 and 3 also show that Keep's method of casting test bars in yokes does

not affect the character of test bars, as no end pressure is exerted on them. Curve 1 was taken by attaching pins *a a* of the recorder to the yoke in flask and then pouring a bar; showed that the yoke opened up rapidly and kept spreading for twelve minutes. At the same time, the curve 2 was obtained from the bar itself and shows that the expansion is much less than that of the yoke, and that the yoke and bar could only have been in contact at the instant of pouring, and never again thereafter.

The curve 3 was obtained from the same iron poured in a flask without placing a yoke in the sand, and this being almost identical with curve 2 proves still more that the yoke has no effect on the bar cast between its ends.

Curves were obtained from all shapes of bars mentioned in the report of the committee, and it is clearly shown that the rate of cooling is a very important factor, as proven by the following curves; the time of producing

CURVES FROM VARYING SIZES OF BARS,

the greatest expansion varying from 2 minutes in the case of bars ½ inch square to more than 150 minutes in 4-inch square bars; strips of metal ½ inch thick cooled off so rapidly that no variation in shrinkage was shown. The times of occurrence of maximum expansion were as follows:

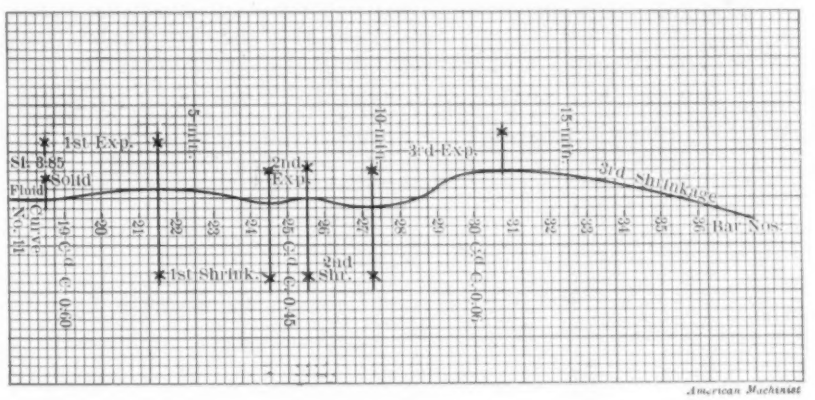
No. of Curve.	Size of Bar.	Time.	Ratio of Section.
17	⅛″ x 1″	0	1 (?)
18	½″ sq.	¾	2
11	1″ sq.	13¾	8
19	1″ x 2″	22	16
20	2″ sq.	45	32
21	3″ sq.	95	72
22	4″ sq.	150 +	128

When these times of expansion and ratios of section are plotted on a diagram so that the first are laid off as abscissæ while the other are used as ordinates, the line through these points of intersection is almost perfectly straight, proving that these curves are directly dependent upon the rate of cooling of the castings, or that a curve obtained from a small bar is merely that from a large bar foreshortened in proportion to the relative sizes of the bars; hence any size of bar which produces curves will give a characteristic curve of the iron, and larger or smaller bars need not be used. There is no doubt in my mind that round bars should have been used in order to obtain the most perfect and characteristic curves, as the cooling and molecular arrangement would have been more uniform and perfect.

It appears that while the first part of curves 4 to 10, recorded within 7½ minutes from the instant of pouring, is solely due to effect of heat expansion of the shell formed instantaneously when the liquid metal strikes the sides of the mold, that part of the curves recorded later is entirely due to the molecular arrangement or crystallization of the metal.

This is shown much better by curve No. 11, reproduced on a large scale in Fig. 5. Beyond this the experiments have not yet been carried, except to show that pouring the bars very hot or very cold changes the curves materially, without as yet giving any definite indications. Before these can be obtained, careful observations of temperatures during cooling must be made, which will be done by a Le Chatelier pyrometer.

The curves, no doubt, settle the vexed question as to whether cast-iron shrinks, or expands and then shrinks, by proving that some iron *does*, and some *don't*. Similar curves were obtained from low carbon (.20 per cent. C) cast-steel; these do not show any expansion in the mold, but very large and rapid shrinkage, and at the same time marked irregularities in the curve due to molecular arrangement.



COOLING CURVES OF CAST-IRON.—FIG. 5.

SERIES.		PER CENT. OF COMBINED CARBON.						PER CENT. OF GRAPHITIC CARBON.						Average Total Carbon.
		⅛″ sq.	1″ sq.	1″ x 2″.	2″ sq.	3″ sq.	4″ sq.	⅛″ sq.	1″ sq.	1″ x 2″.	2″ sq.	3″ sq.	4″ sq.	
Iroquois	1	1.46	1.25	1 05	.80	.76	.70	2 36	2.60	2.83	3.08	3.05	3 13	3.845
	2	.70	.54	.59	.56	.54	.60	3.20	3.32	3.24	3.33	3.32	3.31	3.875
	3	.48	45	.42	.37	.34	.13	3.21	3 28	3.32	3 40	3.36	3 55	3.720
	4	.45	.48	.43	.36	.11	.50	3.10	3.24	3.27	3.41	3.60	3.25	3.700
	5	.35	.16	.20	.11	.10	.10	3 79	3.40	3.34	3.47	3.38	3 42	3 536
	6	.37	.38	.30	.15	.11	.08	3 01	3 08	3.08	3 24	3.19	3 23	3.370
Hinkle	7	1.24	.88	.72	.53	.52	.46	2.78	3.13	3.2	3.42	3.48	3.55	4.000
	8	.67	.44	.50	.49	.46	.42	3.17	3 44	3.3	3.29	3.37	3.42	3 833
	9	.53	.42	.50	.46	.15	.11	3.28	3.47	3.36	3.46	3.67	3.72	3 855
	10	.29	.36	.43	.37	.44	.45	2.91	2 87	2.86	2.84	2.80	2.82	3.240
	11	.32	.12	.09	.09	.08	.08	3.00	3.22	3.22	3.25	3.28	3.23	3.330
	12	.27	.09	.09	.09	.09	.09	3.07	3 28	3.24	3.26	3.28	3 22	3.743
Southern	14	.26	.15	.14	.09	.09	.08	2 89	3.08	3.13	2.18	3.14	3.20	3 238
	13	.11	.10	.09	.08	.07	.07	3.03	3 06	3.07	3.07	3.04	3 08	3 145
	15	.10	09	.09	.09	.11	08	3.03	3.01	3.07	3.06	3.03	3.11	3.146
Britting	16	.86	.75	.76	.74	79	.75	2.50	2 51	2 52	2.52	2.52	2.52	3.275

TRANSVERSE BREAKING LOADS.

No. of Series.	Dimensions of Test Bars.									
	½″ sq. x 12″.	1″ sq. x 12″.	1″ sq. x 24″.	1″ sq. x 48″.	1″ sq. x 54″.	1″ x 2″ x 12″.	1″ x 2″ x 24″.	2″ sq. x 24″.	3″ sq. x 24″.	4″ sq. x 24″.
Iroquois. 1	289	2,589	1,013	513	468	4 181	1,857	6,400	25,200	54,500
2	339	2,140	1,023	562	471	4,050	1,958	7,050	22,800	50,450
3	389	2,619	1,248	....	518	4,300	2,290	7,150	19,250	42,700
4	427	2,620	1,200	556	517	4,336	1,852	7,025	19,300	48,750
5	430	.....	1,232	585	540	.....	2,128	8 400	23,175	42 600
6	471	2,214	.....	557	429	4,180	.....	6,225	17,750	42,150
Hinkle. 7	338	2,186	1,073	468	450	4,030	1,708	6,650	22,750	43,350
8	395	2.457	1,100	528	463	4,272	1,925	7,050	22,175	53,450
9	329	2.356	1,088	527	490	.....	1,753	6,850	18,850	46.300
10	439	2,185	1,042	...	458	3,775	.....	6,640	20,550	51,500
11	443	2.290	.....	581	503	4,110	2.166	6.850	21 575	44 400
12	456	2,105	1,330	501	....	3,673	1 940	7,800	27,900	45,400
Southern. 14	378	2,592	1,200	612	512	4,765	1,968	8 450	24,050	55,050
13	394	.....	1,173	....	....	.. ...	2,200	8 275	25,250	52 450
15	427	.....	1,117	....	....	.....	.....	8,650	22,700	56,350
Foundries. 16	378	.....	1,104	...	....	.....	2,079	7,250	22,150	44.500
17	471	.....	1,424	....	..	.....	2.661	13,450	41.800	92.000
18	446	.....	1,300	....	....	.....	2.352	8,200	25.350	58 700
19	377	.....	1,292	.. .	....	.....	2,703	9,600	31,600	68,500

Bids for Torpedo Boats.

Bids were opened on the 10th by Secretary Herbert, for the construction of the three seagoing torpedo boats, authorized by the Naval Appropriation Bill.

The cost of the vessels complete, armor, etc., was limited to $175,000 each, and the act provided for the construction of one on the Mississippi River, one on the Pacific Coast, and one on the Gulf.

Four bids were received, three from the Pacific Coast, and one from the Atlantic, none from the Mississippi or Gulf States.

The Union Iron Works, of San Francisco, offered to build one of the vessels for $175,000; two for $173,000 each, and three for $172,000 each.

Wolf & Zweicker Iron Works, of Portland, Ore., offered to construct one vessel for $188,700.

Moran Bros.' Company, of Seattle, Wash., bid $163,350 for one boat.

These offers were to build on plans furnished by the Navy Department.

The Herreshoff Manufacturing Company, of Bristol, R. I., the yacht-building firm, offered to construct one or all three of the vessels at $144,000 each. This bid was for plans prepared by the company, which were submitted with the bids.

Pneumatic Mine Locomotives.

The daily papers are noting the recent shipment of pneumatic locomotives to be employed in mines, one going to Alaska, and one to British Guiana. The use of compressed air for mine haulage may be new at the distant points to which these locomotives are going, but it is not, as intimated, a novelty here, as the Pittsburg firm that ships these engines has had an established business in this line for several years, and their locomotives are in use in numerous mines, and also for surface haulage in some cases. The mine locomotive is not made to be looked at and admired, but is strictly adapted to its work. Two large horizontal receivers are mounted on a car, and the engine is all placed beneath it. The valves are operated by link motion, and all the wheels are drivers. The usual charging pressure is about 300 pounds, and a pressure reducer delivers it for the use of the engine at 100 pounds or less. No attempt is made in mines to reheat the air before using. Where the mine is supplied with air at 75 pounds pressure, or so, for the use of the rock drills and such purposes, a compressing pump operated by this pressure is used to re-compress the air to the additional pressure required for the locomotive. It would seem to be advisable to employ much higher pressures for the receivers.

Fast Railroad Service.

On September 11th a special train was run on the New York Central Railroad from New York to Buffalo, a distance of 436½ miles, in 407 minutes, 6 seconds. The object of running this train was to determine the time in which this distance could be advantageously made; the results in detail are as follows:

New York.	Distance.	Time.
Albany.....	143 miles	134 minutes, 00 seconds.
Schenectady.	17 "	19 " 14 "
Utica..... ...	78 "	71 " 00 "
Syracuse	53 "	49 " 30 "
Rochester....	80 "	73 " 06 "
Buffalo.....	65½ "	60 " 16 "
Total.....	436½ miles.	407 minutes, 06 seconds.

From this table we get the extraordinary average speed of about 64½ miles per hour, including 28 slow-ups, but not full stops. The total time for the 436½ miles was 411 minutes. This, we believe, is the fastest time on record for the weight of the train hauled.

The train consisted of one combination smoking and baggage car weighing 83,470 pounds; one passenger car, 82,140 pounds; another passenger car, 83,700 pounds; and a private car, 109,000 pounds, making a total weight of 358,310 pounds, exclusive of the locomotive. The engines hauling the train were No. 870 and 903, each weighing 200,000 pounds, and the famous locomotive 999 weighing 204,000 pounds, designed by William Buchanan, superintendent of motive power.

Gunboats for the Navy.

The Navy Department is calling for proposals for the construction of six new gunboats, to be of about six thousand tons displacement each.

Nos. 10, 11, 12 and 13 are to be 168 feet in length on load water line, 36 feet beam, and 12 feet normal draught to bottom of keel, while Nos. 14 and 15 are to be 174 feet long on load water line, 34 feet beam, and to have a normal draught of 12 feet.

The requirements will be that each vessel shall be constructed of material of domestic manufacture; also the machinery, engines, and boilers. The four first mentioned are to have single screw engines and [illegible] sail power; the latter two will have [illegible] screw engines and steadying sails only. The steel to be used will be subjected to tests which have been already approved by the Secretary of the Navy.

The hulls will be built of material to be supplied by the contractors, while the Government will furnish all masts, spars, sails, blocks, boats, anchors, cables, furniture, carpets, mattresses, and stores of all kinds. The wood to be used will all be treated by a fire-proofing process. Particular stress will be laid upon the cleaning of all steel and iron work. The treatment for all outside and other plates will be as follows: The plates before being taken in hand for working will be immersed for a few hours in a liquid, which will consist of 19 parts of water and one of hydrochloric acid, and the plates are to be pickled on edge, and not laid flat. When they are removed from the

dilute acid, both surfaces will be well brushed and washed, in order to remove any scale which may adhere to them; they will then be bathed with some alkaline solution to neutralize any acid that may remain on the plates, and are then to be thoroughly washed by a hose with fresh water.

The flat steel plates will be continuous from stem to fore part of body post, and are to be of steel plate 20 pounds to the square foot, and will be 36 inches wide amidships. The vertical keel will be of steel plating, 15 pounds per square foot. The stems, stern posts, rudders, and shaft tubes are to be of manganese bronze. They will have transverse water-tight bulkheads.

The magazines are to be considered as water-tight compartments, the floors of which will be fitted with portable gratings of white ash; they will be formed of 10-pound steel plates. They will be fitted with fresh air supply, and will also be connected with mechanical ventilation appliances in the hull. The pipes connected with the magazines, along which lightning might travel, will have metallic connection above the non-conducting length, with an iron beam or some other continuous metal conductor, by means of which the electricity will pass, without interruption, to the sea. Provision will be made for flooding the magazines direct from the sea by means of pipes and valves.

The dynamo rooms will be properly stanchioned and supported in order that the floors may be sufficiently rigid. All stanchions will be made of wrought-iron tubes.

The ventilation of both living and store rooms will be on the exhaust system; also that of the electric light plant room and engine room.

The steam-steering engines will be of the "Williamson" pattern.

Portable Drilling and Tapping Machine.

We give herewith an illustration of an improved portable drilling and tapping machine, with capacity for drilling a 1¼-inch hole in cast-iron, and for driving a ⅝-inch tap.

It is arranged to clamp in any desired position, and is driven by a rope or round belt which passes between idlers that can be placed in any desired position around the pulley, so that they not only guide the belt properly, but also secure greater arc of contact with the pulley.

The principal parts and those having to stand the strains are of steel, including the bevel gears, which are cut by the planing process.

The entire driving mechanism on top of the machine is simply clamped to the sleeve, and can be swung around and clamped in any desired position by one screw.

In drilling or tapping, the spindle can be stopped or reversed instantly by shifting the handle shown at the top of the machine.

The feed gearing is differential and can be thrown in or out, giving the spindle a quick return motion by simply pulling a pin in the center of the concave hand wheel. All the gears are entirely inclosed.

The spindle has a vertical movement of 6 inches, and is bored No. 3 Morse taper.

There are four changes of speed which are derived from the special countershaft which accompanies the machine.

The post is 32 inches long, the clamps take 10 inches between them, and the machine is easily handled by one man. It is made by Albert L. Colburn, New Haven, Conn.

The Knowles Steam Pump Works write us: Referring to the recent fire at our works in Warren, Mass., we have noticed in a number of the papers exaggerated reports of the occurrence. We take this means of informing our friends and patrons that the fire was confined to the iron foundry and to one of the pattern houses, and that the total loss will not exceed $140,000, fully covered by insurance. Our facilities are such that very little, if any, interruption will be caused to our business by the above-named fire.

It is announced that the trial trip of the "St. Paul," now nearing completion at Cramps, will take place on the 21st. Experience with her sister ship the "St. Louis," has, it is said, shown the advisability of several changes, and these will be made in the "St. Paul."

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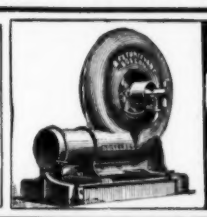
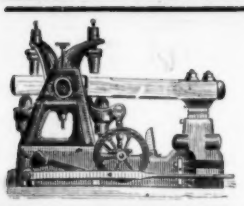


THE STURTEVANT PRESSURE BLOWERS ALL SIZES & STYLES SEND FOR CATALOGUES B.F. STURTEVANT CO. BOSTON, MASS. NEW YORK PHILA CHICAGO LONDON



BRADLEY HAMMERS.

If you plate, draw, square, taper, swage, collar, spindle, or do any manner of die forging in iron or steel, a Bradley Hammer will soon pay for itself by what it will save over any other similar tool. Helve, Upright and Strap Styles. Send for circulars.

THE BRADLEY COMPANY,
SYRACUSE, N. Y.

BORING AND TURNING MILLS

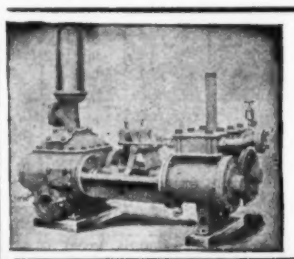
ARE SUPERIOR TO LATHES FOR FACE PLATE WORK.

We have a variety of sizes and a large stock for immediate shipment.

THE BULLARD MACHINE TOOL CO.,

E. P. BULLARD, Pres't. BRIDGEPORT, CONN.

New York Office, 86 LIBERTY STREET.

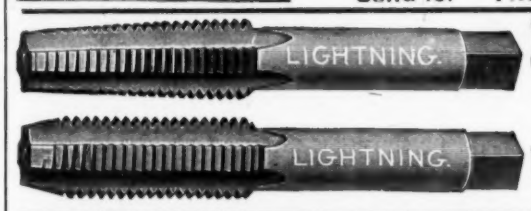


THE DEANE (OF HOLYOKE) Tank Pumps

ALL STYLES.

THE DEANE STEAM PUMP CO.,
HOLYOKE, MASS.

Send for "THE DEANE SPECIALTIES."



Finest Machine Relieved Taps.

Also, Dies, Screw Plates, Reamers, Etc.

SEND FOR CATALOGUE.

WILEY & RUSSELL MFG. CO.,
GREENFIELD, MASS., U. S. A.

GRANT GEARS

Ready Made Iron Gears.
Ready Made Brass Gears.
Gears Made to Order.
Gear Cutting.
1895 Gear Book, Free.
Treatise on Gears, $1.00.
GEORGE B. GRANT,
Lexington, Mass.,
and 125 South 11th St.,
Philadelphia, Pa.,
and 86 Seneca St.,
Cleveland Ohio.

Star Lathes Foot-power Screw Cutting Automatic Cross Feed

9 and 12 inch Swing.

New Designs. Novel Features.

Send for Catalogue B.

SENECA FALLS MFG. COMPANY
687 Water St., Seneca Falls, N. Y.

INDICATOR PRACTICE AND STEAM ENGINE ECONOMY

By F. F. HEMENWAY.

12mo. Cloth, - - - - - - - - - $2.00

JOHN WILEY & SONS, New York City.

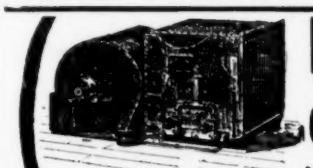
"R. MUSHET'S SPECIAL STEEL"

SAVES LABOR in being able to run at GREATLY INCREASED SPEEDS. FEWER GRINDINGS No WASTE in redressing

SOLE REPRESENTATIVES IN THE UNITED STATES.

B. M. JONES & CO.,

BOSTON: 11 & 13 Oliver St., NEW YORK: 143 Liberty St.



HOT BLAST APPARATUS

VENTILATING, DRYING, HEATING.

GARDEN CITY FAN CO.

SEND FOR CATALOGUE E. MANUFACTURERS OF EXHAUST FANS, PRESSURE BLOWERS, ETC. CHICAGO, ILL. U.S.A.

H. W. JOHNS'

ASBESTOS SECTIONAL PIPE COVERINGS.

NON-CONDUCTING COVERINGS FOR STEAM AND HOT WATER PIPES, BOILERS, ETC.
ASBESTOS BOILER COVERINGS.

H. W. JOHNS MANUFACTURING COMPANY.

H. W. Johns' Asbestos Millboard, Sheathings, Building Felts, Fire-Proof Paints, Liquid Paints, Asbestos Roofing, Etc.

87 MAIDEN LANE, N. Y. JERSEY CITY, CHICAGO, PHILADELPHIA, BOSTON, LONDON

NEW CATALOGS.

There are three sizes of Standard Catalogs, 9" × 12", 6" × 9" and 4½" × 6". We recommend the 6" × 9" size for machinery catalogs. When they must be larger or smaller, one of the other standard sizes should be adopted if possible.

We have received a catalog from L. Schuler, Foundry and Machine Tool Works, Goeppingen, Württemberg. It is neatly gotten up, and contains 260 illustrated pages, showing a great variety of tools and machines especially for sheet-metal working. Size of the catalog, 10½"x7".

A. Aller, 109 Liberty street, New York, has issued a folder devoted to the illustration and description of the Korting exhaust steam and induction condenser for steam engines and pumps. It will be found of interest to those who have to do with steam plants, and is sent on application to any address.

Jenkins Bros., 71 John street, New York, have issued a new catalog describing and illustrating various forms of valves, standard packing, and other steam specialties manufactured by them. Full particulars with prices are given, and it is stated that this is to supersede all previous lists. It is sent to those interested on application, and is 7½"x5".

We have received from A. D. Quint, Hartford, Conn., an illustrated catalog describing the various forms and sizes of Quint's turret drills. The catalog gives full particulars regarding the machines, with diagrams showing their construction, and includes also some reproductions of letters from well-known manufacturing concerns, giving the results of their experience with them. It will be found of interest to those who have drilling to do, and is standard size, 6"x9".

MANUFACTURES.

The Ensign Lumber Co., of Cordele, Ga., has been formed by M. Killian and J. Lee Ensign, with $10,000 capital stock.

At Anderson, N. C., a cotton-mill has been organized by H. H. Watkins and J. J. Fretwell, with a capital of $250,000.

The Wabash (Ind.) Bridge and Iron Works has been incorporated, with a capital of $30,000. John B. Latchem is president.

At New Orleans, La., a company has been organized with $100,000 capital, to manufacture bicycles. Robert W. Abbott is interested.

The Illinois Sash and Door Co., of Chicago, Ill., has been organized by Chas. E. Tullis and Michael Englehart, with a capital of $10,000.

A company has been organized at Tampa, Ala., to erect a brick plant, with a capital stock of $20,000. Syd B. Sturdivant is interested.

A new cotton-mill company has been organized at Henderson, N. C., with $100,000 capital. D. Y. Cooper and E. G. Davis are interested.

A. G. Couch and W. B. Edwards, Jr., of Senoia, Ga., have incorporated the Couch-Banks Manufacturing Co., with a capital stock of $10,000.

The Springer Separator Co., of Philadelphia, Pa., has been incorporated by Thos. H Springer and W. B. D. Smith, with a capital of $150,000.

The Ozark Stone & Lime Co. has been organized at Kansas City, Mo., with a capital stock of $40,000. H. E. Stillwell and Wm. L. Mott are interested.

The American Power and Tide Wheel Co., of San Francisco, Cal., has been formed by A. H. St. Marie and others, with a capital of $500,000.

A company has been formed at Henderson, N. C., with $100,000 capital, to erect a mill. D. Y. Cooper is president, and E. G. Davis, secretary.

The August Maag Co., of Baltimore, Md., has been incorporated by August Maag and others with $25,000 capital stock, to manufacture tools.

The Dickenson & Randall Joint Box Co., of Alexandria, Va., has been incorporated by Chas. Dickenson and others, with $50,000 capital stock.

The Wilson Manufacturing Co., of Baltimore, Md., has been organized with a capital stock of $30,000, by Harry M. Wilson and Francis P. Curtis.

The Interlaken Company, one of the largest manufacturing corporations in Rhode Island, will begin the erection at once at Arkwright of a mill to cost $1,000,000, and to have a capacity of 40,000 spindles, for the production of cotton cloths.

The Montauk Steamboat Co. have given a contract to the Harlan & Hollingsworth Co., of Wilmington, Del., for a new steamboat, which will be 298 feet long, 62 beam, and will have engines of 1,700 horse-power, and a guaranteed speed of 17 miles per hour.

Machinists' Supplies and Iron.

NEW YORK, September 14, 1895.

Iron—American Pig—We quote standard Northern brands, $14 for No. 1; $13 for No. 2; $12.75 for No. 2 Plain, and $12.50 for Gray Forge. Southern brands, $14 for No. 1; $13.50 to $13.75 for No. 2; $13 to $13.50 for No. 3; $13.50 to $14 for No. 1 soft; $13 to $13.50 for No. 2 soft; and Foundry No. 4, $12.50 to $12.75.

Antimony—The market is unchanged, business is fair, and prices are steady. Cookson's is quoted at 8c. to 8⅛c.; Hallett's, 7⅞c. to 7¾c.; Japanese, 7c.

Lard Oil—Prime City is quoted at 49c. to 50c.

Copper—The market is firm and prices have an upward tendency. It is reported that bids of 12¼c. for Lake Copper have been refused for near future deliveries, and that the price was near 12⅜c.; in fact, this price in a small way has been paid. The demand for Casting Copper is quite good at 11⅝c. to 11¾c., according to brand.

Lead—The market is dull, 3.40c. is quoted, and 3 37½c. has been offered for carloads.

Spelter—The market has improved, and prices are firmer. For New York delivery, 4.25c. to 4 30c. has been paid.

Tin—The market was very active in a speculative way, and spot prices increased from 14.35c. to 14.50c. At 14.35c. a fair business was done outside of speculative circles.

✻WANTED✻

"Situation and Help" Advertisements only inserted under this head. Rate 30 cents a line for each insertion. About seven words make a line. The Cash and Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

TO SUBSCRIBERS.

On and after July 4th this paper will give two free insertions under this heading to those in want of positions. The advertisement to occupy a space of not more than five lines. Additional space or insertions must be paid for in advance at regular rates.

Wanted—Bright, active machinists to canvass for subscription to AMERICAN MACHINIST, liberal commission. Address, with refs., Subscription Dep't, AMERICAN MACHINIST, 203 Broadway, N. Y.

Draftsman, experienced in water pumps and ice machines, wants position. Box 107, AM. MACH.

Foreman patternmaker, thor. in all its branches, desires to make a change. Box 95, AM. MACH.

Position wanted by machinist, sober and reliable. Address G., care AMERICAN MACHINIST.

First-class, up-to-date tool and die maker wants position. Box 105, AMERICAN MACHINIST.

Wanted—Situation as foreman or superintendent of machine shop; best of refs. C., AM. MACH.

Wanted—Mech. engineers and draftsmen, North and West, with evenings free; state pres. position. Edwin Guthrie, Corcoran Bldg., Washington, D. C.

First-class mechanical draftsman wants to change position. R., care of AMERICAN MACHINIST.

First-class foreman boiler maker is open for engagement; is a hustler; 12 years' experience; references; A1 layer out. Box 110, AM. MACHINIST.

Wanted—A draftsman on Corliss engine work; must be a specialist and capable of leading the work. Sparrow's Point, Md., Maryland Steel Co.

Mech'l draftsman (German), 29 years old, with technical education and practical exp., wants position. J. Ecker, 405 N. Lincoln St., Chicago, Ill.

Wanted—Position as superintendent, foundry and machine business, 20 years' exp. in general work. Address Box 97, AMERICAN MACHINIST.

Wanted—Position as superintendent of machine shop, can handle any class of work, and any number of men. Address C. L. W., AM. MACHINIST.

Experienced Designer Wanted—Familiar with all classes of bookbinders' and paper cutting machinery, for the West. Address, stating all particulars, "A," care of AMERICAN MACHINIST.

Wanted—A position by a young man with technical education as draftsman, assistant to master mechanic, or in construction of electrical machinery. H. W., care AMERICAN MACHINIST.

Wanted—A first-class patternmaker, one familiar with heavy saw-mill, woodworking and general machinery; state age, experience and salary expected. Box 101, AMERICAN MACHINIST.

A mechanical engineer wants to make a change-Superintendent or master mechanic. 25 years' experience. Unquestionable proof of ability and character. Address A. L. Y., AMERICAN MACHINIST.

A draftsman having experience in engine work, and graduate of technical school, desires position as draftsman with a reliable firm. Best of references given. Address Technique, AM. MACHINIST.

Wanted—Sit. in N. Y. or Brooklyn as assist. supt. or draftsman; thor. knowledge of mach. construction & design; also exp'd patternmaker & machinist; 12 yrs. exp.; terms mod. Box 111, AM. MACH.

Wanted—Position by toolmaker, who thoroughly understands die, tap, forming and experimental tool work, and who can give the best of references. Address L., care of AMERICAN MACHINIST.

Cupola tender wants situation, light or heavy castings; also metallic bedsteads; experienced in fluxing and slagging large and small cupolas. Address G. Yeates, 2766 Jasper St., Philadelphia.

Wanted—A first-class designer and patternmaker, also A1 machinist as foreman of shop doing light fine work west of the Mississippi. Address M. B., care of AMERICAN MACHINIST.

Wanted—Foreman for machine shop—Corliss engines and general machinery—one who has had some experience in doing work by the piece preferred. Address Box 108, AMERICAN MACHINIST.

Mechanical engineer and draftsman, a young man 28, having technical education, a thorough knowledge of modern shop methods and extensive experience with leading concerns, is open for engagement. Address Box 103, AM. MACHINIST.

A reliable, energetic, married man (35); graduate Rensselaer Polytechnic; 11 years' experience in shop, on the road, and office work; good references; would represent a mfg. concern in the East on moderate salary. Worker, AM. MACHINIST.

Wanted—Foremanship by a competent man on drop forgings and machine blacksmith work; a hustler with several years' experience in charge of tool room and smith shop. Address M. Y., care of AMERICAN MACHINIST.

Wanted—A first-class draftsman; one having experience in the drawing room of an electrical manufacturing company preferred; give age, references, experience, nationality and education. Send samples of work and state salary expected. Fort Wayne Electric Corporation, Fort Wayne, Ind.

Machinist thoroughly conversant with modern practice and requirements with good executive ability, seeks a situation by this means on any class of work; would like to change on or before October 1st. Postal address John T. Usher, 498 Third Avenue, N. Y. City.

✢ MISCELLANEOUS WANTS ✢

Advertisements will be inserted under this head at 35 cents per line, each insertion. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

Cheap 2d hd lathes & planers. S.M.York, Clev'd, O.

Calipers & Gauges. F. A. Welles, Milwaukee, Wis.

(*Continued on Page 754.*)

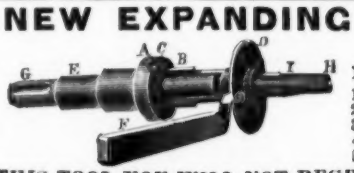
LECOUNT'S NEW EXPANDING MANDREL.

Amateur's Size.

Taking anything from ⅛ to 1 inch inclusive.

Price.....$5.00

Patented Dec. 25, 1877.



Machinist's Size.

No.			Price.
1	⅛ to 1	in.	$10
2	1	" 1½ "	14
3	1½	" 2 "	18
4 (with screws)	2	" 3 "	32
5 "	3	" 4 "	44

IF YOU WILL TRY THIS TOOL YOU WILL NOT REGRET THE EXPENSE.

C. W. LECOUNT, SOUTH NORWALK, CONN.

SPECIAL MANDRELS FOR SPECIAL JOBS MADE TO ORDER.

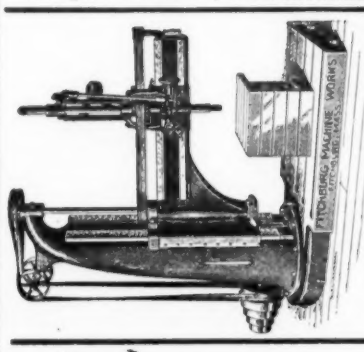
These goods are for sale by CHAS. CHURCHILL & CO., L'td. 21 Cross St., London, England.

DON'T ACCEPT ANY SUBSTITUTE FILE.
INSIST ON HAVING
NICHOLSON

NICHOLSON FILE CO.

PROVIDENCE, R. I., U. S. A.

3000
VARIETIES FILES
[X. F.] & INCREMENT CUT FILES.



RADIAL DRILL 6 FT.

FITCHBURG MACHINE WORKS,

FITCHBURG, MASS., U. S. A.

SPECIAL : : MACHINERY.

Send for Catalog E, of Lathes, Planers, etc.

BUILDERS IRON FOUNDRY,

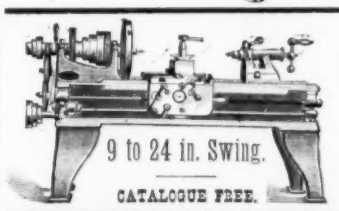
FOUNDERS AND MACHINISTS,

PROVIDENCE, R. I.

We can guarantee that our castings will be uniform and of high tensile strength.

Tensile strength of ten specimens taken from an air furnace heat:

34,260 lbs.	34,390 lbs.	32,600 lbs.	33,200 lbs.	34,400 lbs.
36,420 "	34,650 "	32,460 "	36,550 "	36,700 "



CATALOGUE FREE.

FOUR POINTS!!!!

DESIGN! WORKMANSHIP! MATERIAL! FINISH!

All these are comprised in the make-up of our lathes and are the four necessary points in the construction of a good tool. Add to these a FIFTH and a very important one, the price, which we make very low to prompt cash buyers, and you have the story. Our catalogue will tell you all about our lathes, planers, shapers, etc.

SEBASTIAN LATHE CO.,

117 and 119 CULVERT ST., CINCINNATI, OHIO, U. S. A.

ROOTS' NEW ACME HAND BLOWER.

For Blacksmiths, etc. Slow Speed, Positive Blast. Is Durable Compact and Cheap; also Portable Forges, Tuyere Irons and Foundry Blowers.

P. H. & F. M. ROOTS, Mfrs.
CONNERSVILLE, IND.
Chicago Office: 1405-10 MANHATTAN BUILDING.
COOKE & CO., Selling Agents,
163 & 165 Washington St., NEW YORK.
Please Mention This Paper.

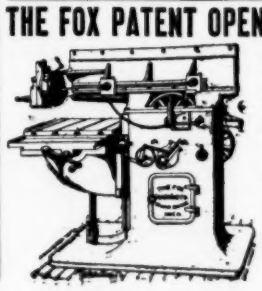
HENRY CAREY BAIRD & CO.,

INDUSTRIAL PUBLISHERS, BOOKSELLERS AND IMPORTERS,

810 Walnut St., Philadelphia.

☞ Our New and Revised Catalogue of Practical and Scientific Books, 88 pages, 8vo., and our other Catalogues and Circulars, the whole covering every branch of Science applied to the Arts, sent free and free of postage to any one in any part of the world who will furnish his address.

THE FOX PATENT OPEN SIDE SHAPER.



No springing of ram. No overhanging table. Quick Return, Stroke Under Perfect Control. Can be Instantly Adjusted 1-16 in. or 24 in. No Screws to Monkey with. Powerful, Quick, Accurate. Write for circular.

The Fox Machine Co.,
325 N. Front St.,
Grand Rapids, Mich.
135 Finsbury Pavement, London, England

The Elliott Drill Press

FOR ANY LIGHT WORK.

LARGE RANGE OF WORK—LOW PRICE.

THE ELLIOTT DRILL.

Now Manufactured by

A. J. WILKINSON & CO.,

180 to 188 WASHINGTON ST., BOSTON, MASS.

SEND FOR CATALOGUE.

CHAS. A. STRELINGER & CO.,

Tools, Supplies and Machinery,

DETROIT, MICH.

WORTHINGTON STEAM PUMPS

FOR ALL DUTIES.

HENRY R. WORTHINGTON,

NEW YORK, 86 and 88 Liberty St. BOSTON, 70 Kilby St. PHILADELPHIA, 607 Arch St. CLEVELAND, 24 South Water St. CHICAGO, 185 to 189 Van Buren St. ST. LOUIS, Eighth and St. Charles Sts. INDIANAPOLIS, 64 South Pennsylvania St. DETROIT, 155 Jefferson Ave

Light and fine mach'y to order; models and electrical work specialty. E. O. Chase, Newark, N. J.

For Sale—A first-class key-seater, new. Address Mitts & Merrill, 913 Tilden St., Saginaw, Mich.

Best and cheapest Bolt Header made by C. H. Baush & Sons, Holyoke, Mass.

Wanted—A purchaser for a good key-seater, by Mitts & Merrill, 913 Tilden Street, Saginaw, Mich.

Wanted—Good 2d-hand air compressor; give full particulars. Address Armour & Co., Chicago, Ill.

Pat's obt'd; no atty's fee until allowed; exp't service. Thurman & Silvius, mech. engs., Ind'polis, Ind.

Wanted—Machinery to build: special, steam, mill, hydraulic. F.C. & A. E. Rowland, New Haven, Conn.

For Sale—One Robbin's lathe milling attachment, $25; described in AMERICAN MACHINIST June 28, 1894; stamp for reply. BOX 109, AM. MACHINIST.

Wanted—To correspond with any one in need of a first-class key-seater, Address Mitts & Merrill, No. 913 Tilden Street, Saginaw, Mich.

For Sale Cheap—100,000-pound Riehle testing machine, in good order. Address Alfred Box & Co., Front and Poplar streets, Philadelphia, Pa.

Any manufacturer of machine tools or special machinery desiring direct representation in New York City can learn something to his advantage by addressing Box 106, care of AMERICAN MACHINIST.

For Sale—Tabor duplex automatic molding machine with 18-inch cylinder; molds two flasks 12x15, or one flask 15x24 inches; perfect condition. Box 94, AMERICAN MACHINIST.

For sale—Two 22" Plain Hamilton Drill Presses, one 26" back gear and power-feed Hamilton Drill Press, one 30" Springfield Tool Grinder. These are new machines and will be sold cheap for cash. Dietz, Schumacher & Co., Cincinnati, Ohio.

For Sale—A foundry and machine shop together, with steam engine and boiler, also shafting in the same; plant is located 30 miles from Chicago on the Outer Belt Line which connects with all railroads entering Chicago. Address J. P., AMERICAN MACHINIST.

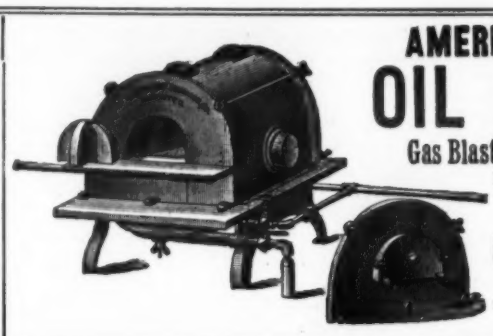
Wanted—An Idea. Who can think of some simple thing to patent? Protect your ideas; they may bring you wealth. Write John Wedderburn & Co., Patent Attorneys, Washington, D. C., for their $1,800 prize offer.

Wanted—An up-to-date second-hand tapping machine, for tapping cast-iron pipe fittings ¼-inch to 2 inches, or larger; also a good second-hand pipe machine, to cut and thread wrought-iron pipe 4 inches to 10 inches. T. McAvity & Sons, St. John, N. B., Canada.

NOTICE TO ENGINEERS AND ENGINEERS' SUPPLY FIRMS.

An Auction Sale of Lubricating Cups of Stauffer and Reisert Patents (the latter self feeders), also, a few 25-lb. cans of imported Lubricating Compound, at 106 Liberty Street, Basement. Wednesday, October 2d, at 11 A. M. by

A. & F. RÖLKER, AUCTIONEERS.



AMERICAN GAS FURNACE CO.,

OIL GAS PLANTS

Gas Blast Furnaces & High Pressure Blowers

For the economical generation and systematic application of HEAT.

CATALOGUES ON APPLICATION.

No. 80 Nassau St., - NEW YORK.

ENGLISH AGENCY:
Chas. Churchill & Co., Ltd., 21 Cross Street, Finsbury, London, E. C., England.

CLEVELAND

ESTABLISHED IN 1874.

CLEVELAND TWIST DRILL CO.

99 Reade Street, New York.
85 Queen Victoria Street, London, Eng.
5 Neue Promenade, Berlin, C., Germany.
Cor. Lake and Kirtland Streets, Cleveland, O.

SECOND-HAND TOOLS.

MODERN STYLE. FIRST-CLASS ORDER.

Will Be Sold Very Low Before Removal.

ENGINE LATHE—Flather, 14 x 6 ft., Hollow Spindle, Cross Feed.
" " Blaisdell, 16 x 6 ft., Raise and Fall Rest.
" " Pratt & Whitney, 16 x 7 ft., Raise and Fall Rest.
" " Putnam, 16 x 8 ft., Raise and Fall Rest.
" " Flather, 18 x 8 ft., Hollow Spindle, Cross Feed.
" " Pond, 20 x 8 ft., Compound Rest, Cross Feed.
" " Harrington, 20x10 ft., Compound Rest, Cross Feed
" " New Haven, 25 x 12 ft., Cross Feed and Chuck.
" " Fay & Scott, 36x18 ft., Compound Rest, Cross Feed.
" " Fifield, 40 x 10 ft., Compound Rest, Cross Feed
" " Union, 72 x 29 ft., Triple Geared, Screw Feed, Cross Feed, etc.
PLANER—Pease, 22 x 5 ft., Heavy Pattern.
" Fitchburg, 27 x 8 ft., Automatic Feeds.
" Harrington, 30 x 10 ft. Heavy Pattern.
" Betts 36 x 12 ft., Heavy Pattern.
" Gray, 48 x 12 ft., "Latest," 2 Heads.
SHAPER—Gould & Eberhardt 15 in. Crank.
" Prentiss 17 in. Crank. Good as new.
" Hendey 24 in. Friction.
" Prentiss 32 in. Friction.
" Fitchburg 34 in. Traveling Head, 28 in. Feed.
DRILL—Prentice 22 in., Friction Pulleys for tapping.
" Blaisdell 28 in., Back Gears.
" Hamilton 28 in., Back Gears, Automatic Feed.
MILLING MACHINE—Pratt & Whitney No. 2, Hand Feed and Vise.
" " Garvin No. 3 Miller, Power Feed.
" " Kempsmith Universal Miller.
" " Lincoln Pattern Millers with Vises.
SCREW MACHINE—Bardons & Oliver's No. 2 Screw Mach. Wire Feed.
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9 ft. Holly Mfg. Co., Radial.

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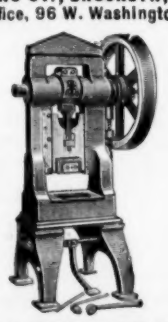

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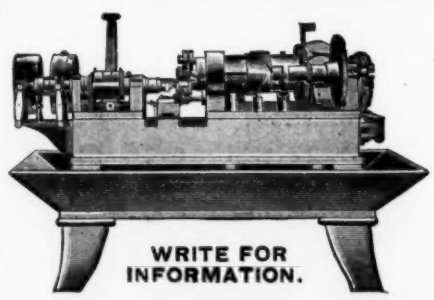

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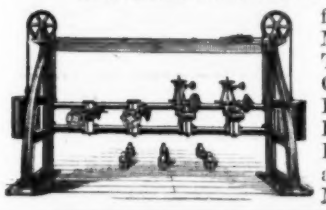

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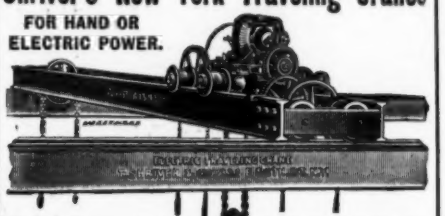

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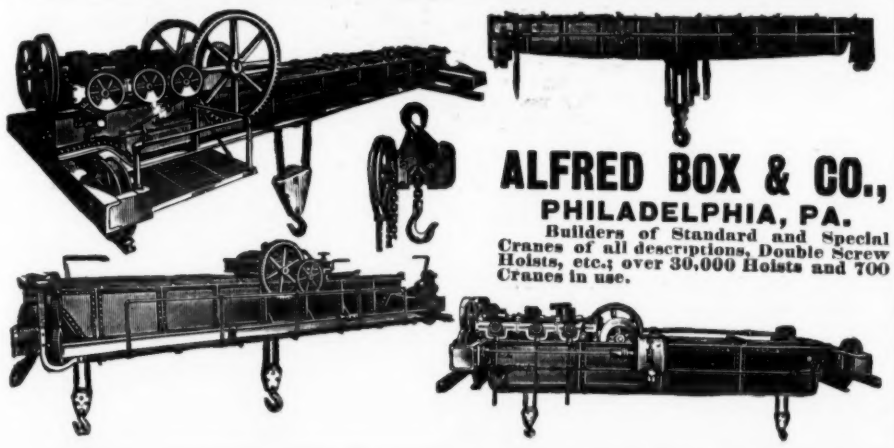

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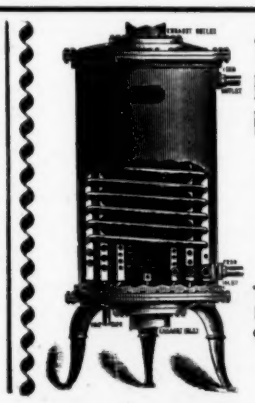

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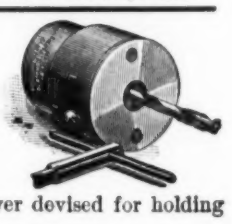

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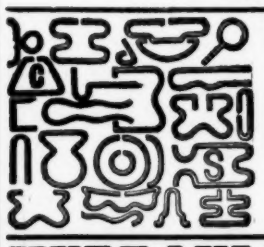

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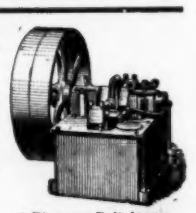

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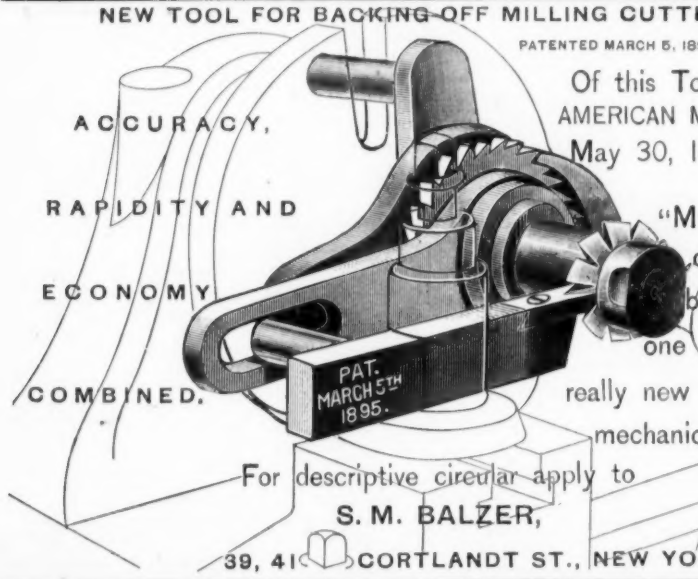

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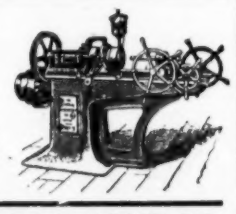

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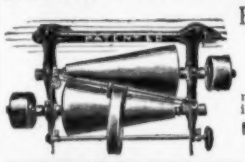

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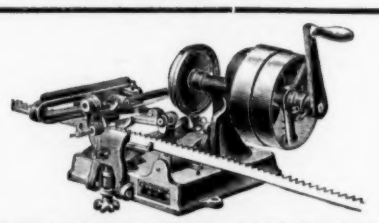

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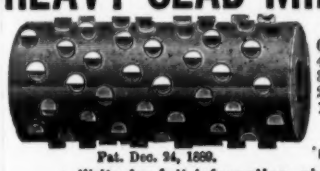

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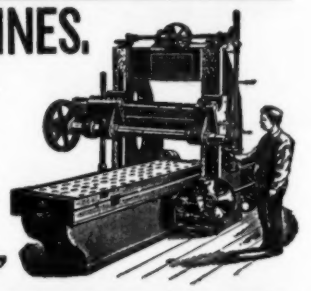

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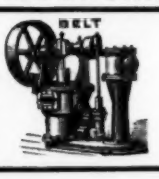

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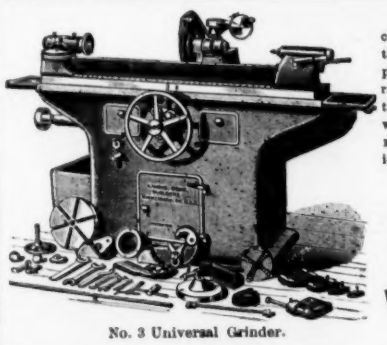

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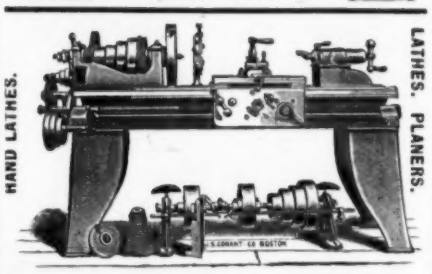

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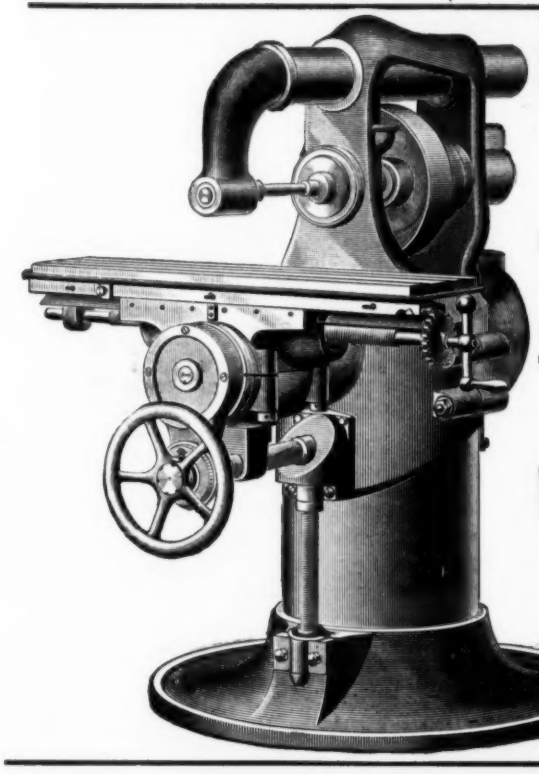

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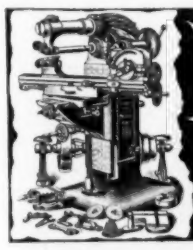

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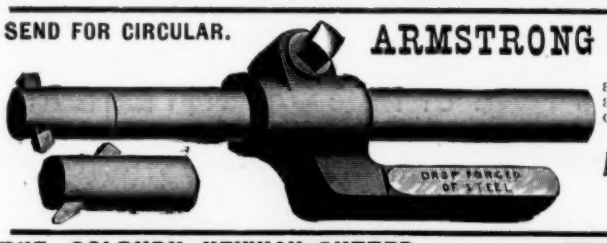

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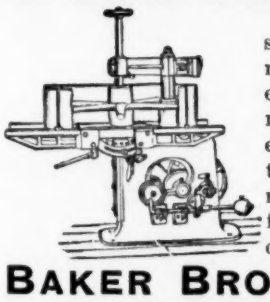

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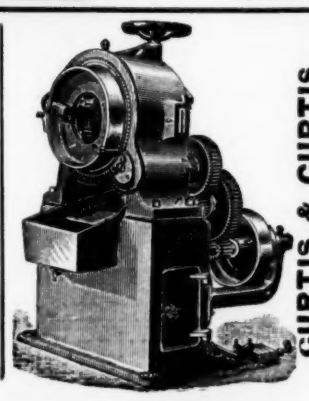

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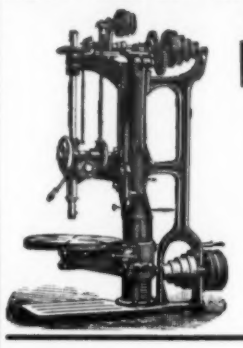

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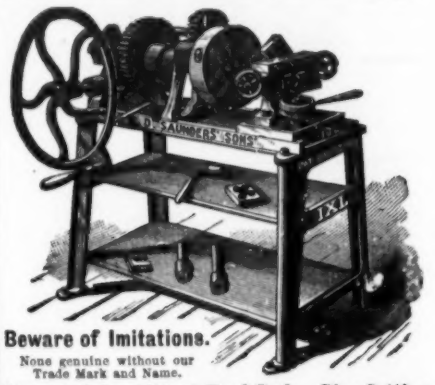

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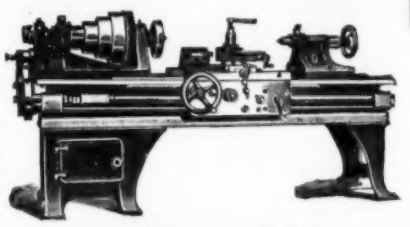

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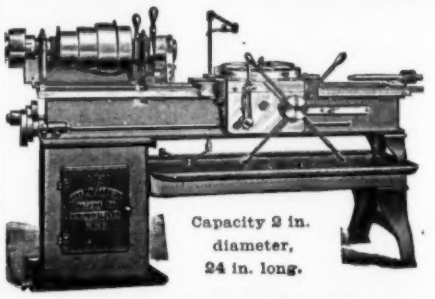

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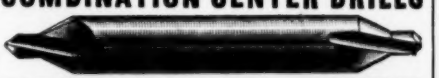

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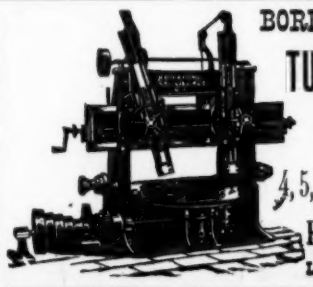

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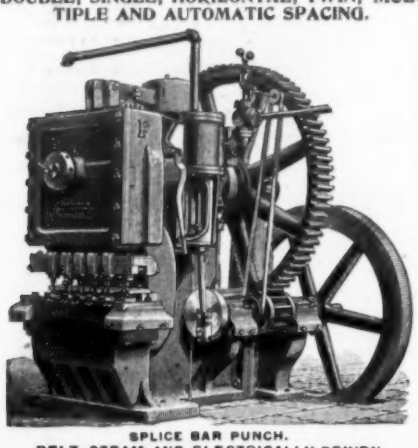

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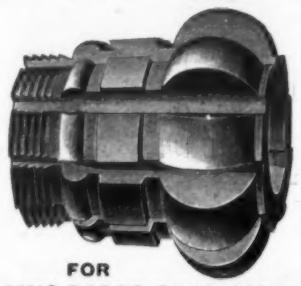

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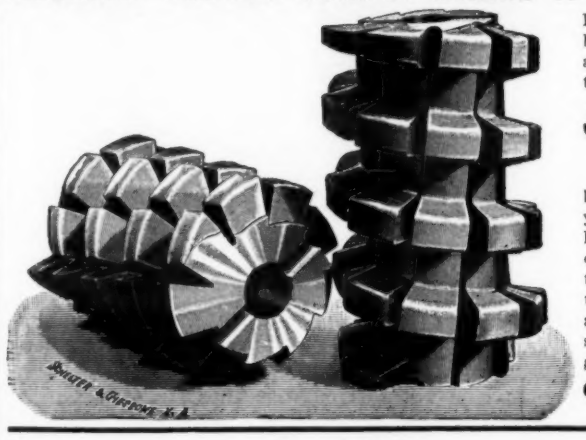

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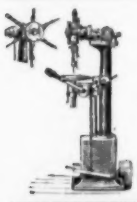

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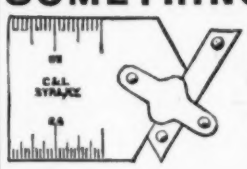

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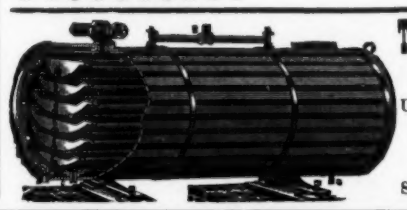

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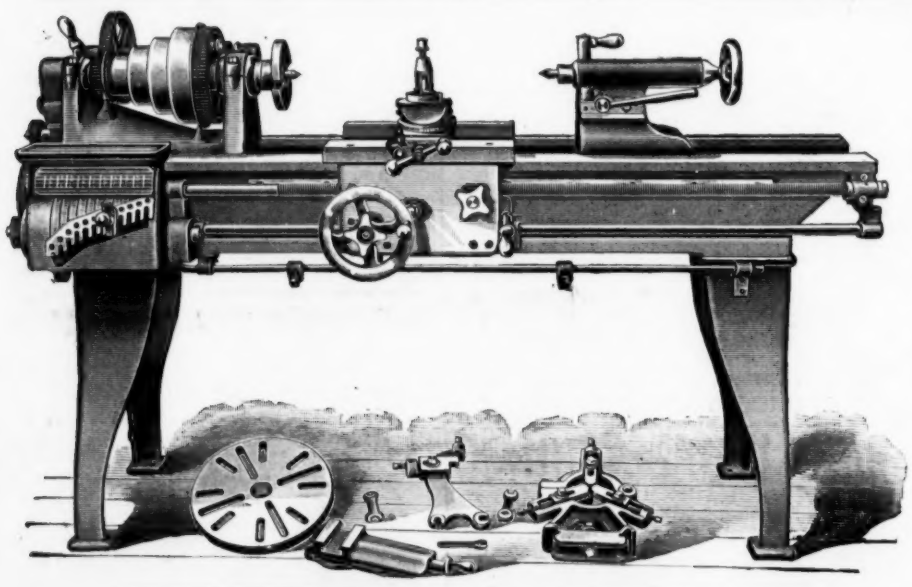

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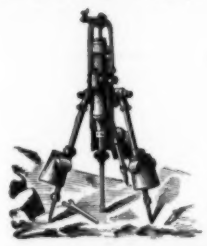

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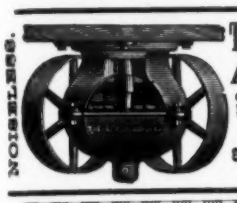

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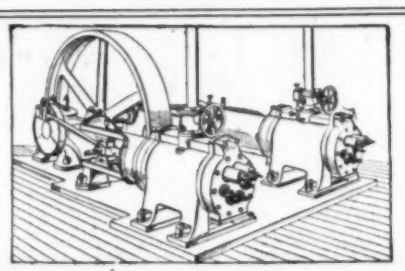

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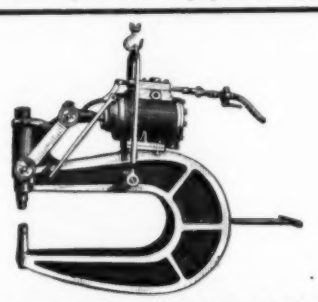

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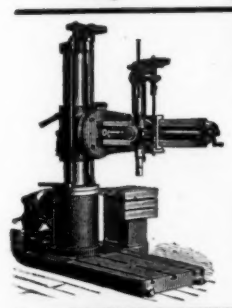

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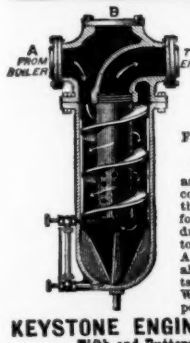

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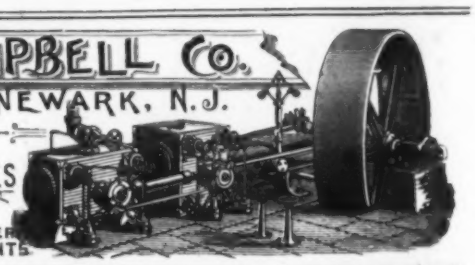

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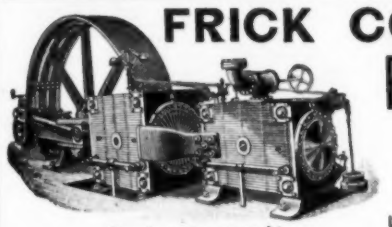

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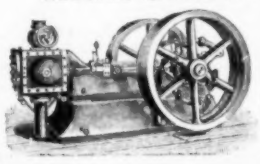

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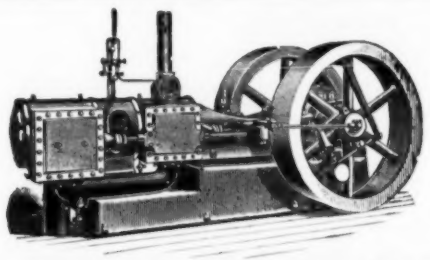

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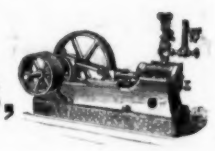

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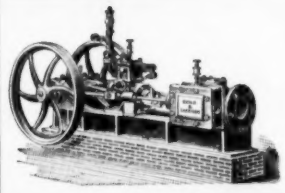

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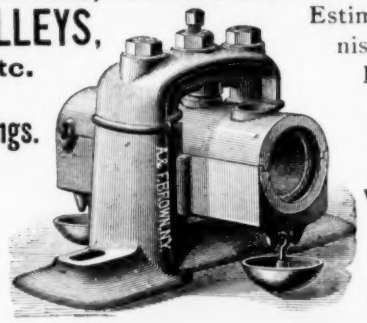

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SINGLE CUTTER.

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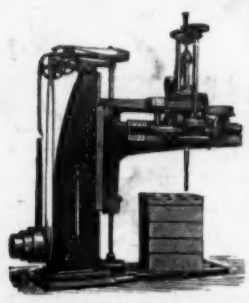

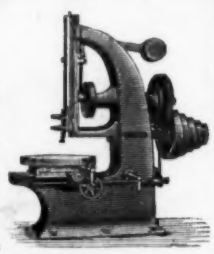

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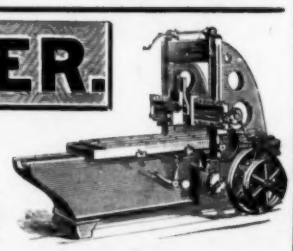

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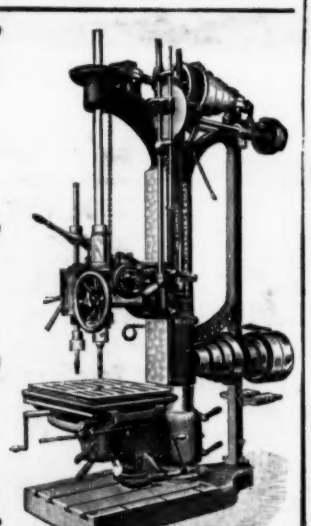

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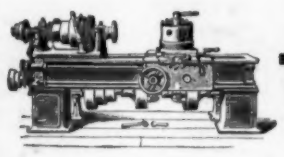

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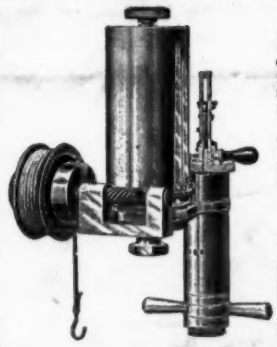
Fitted with HOUGHTALING REDUCING MOTION.



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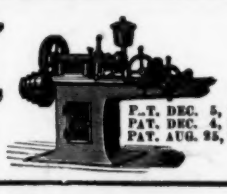

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15", 24" and 25" stroke.
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